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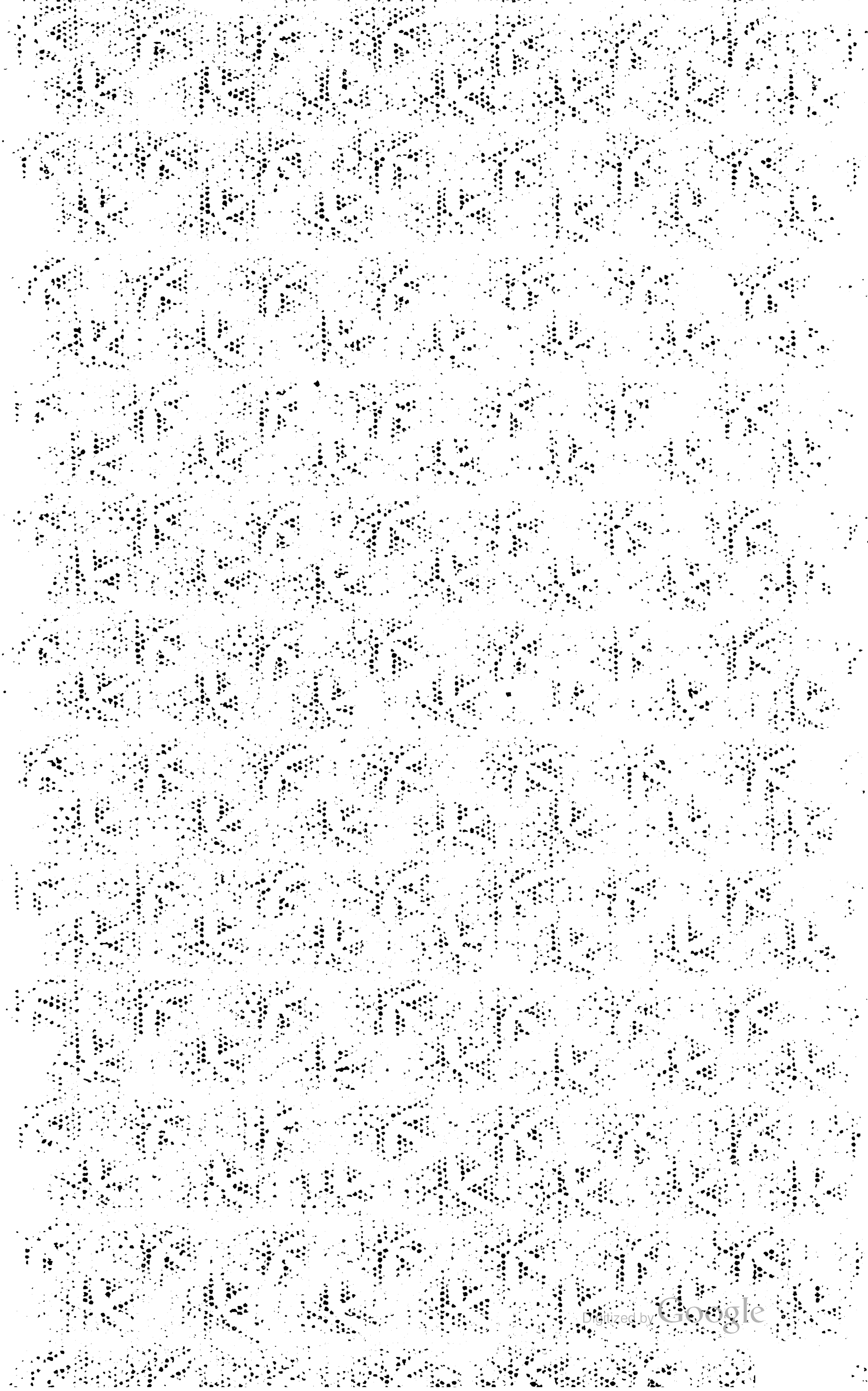

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A. P. Lathrop—1900. Irvin Butterworth—1894.
John D. McIlhenny—1904.
C. W. Andrews—1903. George Whysall—1901.

PROCEEDINGS

OF THE

Ohio Gas Light Association

Twentieth Annual Meeting

HELD AT

THE HOLLENDEN HOTEL,
CLEVELAND, OHIO.

March 16th, 17th and 18th, 1904.

PUBLISHED BY THE ASSOCIATION
EDITED BY THE SECRETARY.

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1904.

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TWENTIETH ANNUAL MEETING

OF THE

Ohio Gas Light Association

HELD

MARCH 16th, 17th, and 18th, 1904.

PROCEEDINGS.

First Day—Morning Session.

At 9:30 o'clock A. M. the Association was called to order by the President, Mr. John Dexter McIlhenny. Upon roll call, the following members reported their attendance:

Abell, H. C.,
Auner, Harry,
Armstrong, F. S.,
Alcott, F. L.,
Arthur, W. A.,
Arthur, Chester L.,
Barnes, Geo. W.,
Blanchard, Harry,
Baxter, Isaac C.,
Barthold, W. H.,
Beadle, A. B.,
Bredel, Fred.,
Bernstein, S.,
Binkley, F. C.,
Bigelow, L. S.,
Blinks, Walter M.,
Blowers, Frank W.,
Block, Barnhard,
Boyle, W. C.,
Brooks, F. F.,
Buck, Earl H.,
Butterworth, Irvin,
Callanan, J. M.,
Chase, Louis,
Clapp, G. N.,
Cavanagh, Frank,
Cartright, H. R.,
Clark, Horace F.,
Cressler, Geo. H.,
Cressler, Alford M.,
Cressler, A. D.,
Cochran, Horace J.,
Collins, Warren,
Coombs, Moses,
Coombs, Fred. S.,
Cobb, B. C.,
Corbus, F. G.,
Dales, J. M.,
Davis, Ernest M.,
Daley, Edward M.,

Daly, Martin B.,
Davis, C. R.,
Daugherty, George,
Dewey, V. F.,
Dickey, Edmund S.,
Dolph, Alex. M.,
Doherty, Henry L.,
Dole, H. N. P.,
Droulliard, G. L.,
Doty, Paul,
Eaton, Alfred B.,
Faben, Chas. R., Jr.,
Field, Frank H.,
Field, R. A.,
Frost, Wm., H.,
Gassett, A. L.,
Ganser, H. H.,
Graf, Carl H.,
Gray, A. Ross,
Greenough, Mal. S.,
Gillette, J. Walter,
Guldlin, O. N.,
Gwynn, J. W.,
Hayward, Sterling F.,
Hamlink, L. C.,
Haines, Jansen,
Harrop, Dr. H. B.,
Hammon, W. H.,
Hedges, W. G.,
Hedges, J. S.,
Hicks, Geo. C., Jr.,
Hilleke, A. F.,
Hibberd, E. G.,
Hoffman, R. J.,
Humphreys, H. S.,
Humphrey, A. H.,
Hyde, Gustavus A.,
Jones, T. C.,
Johnston, E. D.,
Kauke, John H.,
Klein, B. F.,
Kellum, Benj. J.,
Kirk, F. M.,
Knight, William H.,
Knight, John J.,
Koiner, C. W.,
Keutz, J. C.,
Lawlor, R. H.,
Lea, Henry I.,
Lindsey, E. C.,
Low, D. W.,
Lord, R. S.,
Lloyd, Ernest F.,
Lynn, James T.,
McCallum, J. N.,
McDonald, Albert,
McDonald, Donald,
McDonald, Donald,
McIlhenny, John D.,
McLean, Geo.,
McMahon, J. W.,
Marks, R. J.,
Mann, Howard E.,
Madden, James,
Magee, Robert S.,
Mayer, John L.,
Malone, M. E.,
Maloney, Andrew P.,
Mason, John T.,
Mancourt, Edward M.,
Mansur, John H.,
Many, F. B.,
Megie, Benj. F.,
Miller, R. W.,
Miller, W. H.,
Morreau, Albert,
Morris, Daniel,
Montgomery, Randall,
Mullen, John J.,
Mulholland, S. E.,
Neeley, J. D. S.,
Olds, H. L.,
Owens, H. G.,
Osbourne, W. M.,
Osius, Geo.,
Parker, Geo. W.,
Palmer, Louis T.,
Pattrell, C. B.,
Perkins, B. W.,
Persons, Fred. R.,

Perry, A. T.,
Price, W. W.,
Pinkney, E. A.,
Printz, Eugene,
Printz, Chas. H.,
Powell, Wm. R.,
Richardson, W. W.,
Ritter, Chas. S.,
Robb, J. M.,
Ross, J. Chas.,
Ross, W. H.,
Russell, D. R.,
Schall, H. D.,
Schwarm, C. A.,
Shacklette, R.,
Slater, A. B., Jr.,
Stacey, A. J.,
Stacey, F. A.,
Strain, G. A.,
Stevens, J. G.,
Steenbergen, Chas. L.,
Steele, Geo. P.,
Steinwedell, W. E.,
Sherwood, E. J.,
Smith, Arthur C.,
Smith, Arthur M.,
Smith, Ernest B.,
Schnierle, E. H.,
Scott, G. C.,
Sloper, H. T.,
Stone, F. W.,
Tracey, Walter B.,
Tayler, George H.,
Trenkamp, H. J.,
Templeton, E. S.,
Tittle, Scott M.,
Tippy, B. O.,
Van Wie, Edwin G.,
Watts, Chas. L.,
Walker, W. L.,
Warmington, Daniel R.,
Wells, L. W.,
Wickham, Leigh,
Whipple, Henry S.,
Williams, C. H.,
Wilkin, John T.,
Wones, W. R.,
Wolff, S. E.,
York, Geo. W.

President McIlhenny:—Gentlemen, we have the honor this morning of having with us M. S. Greenough, President of the Cleveland Gas Light and Coke Company. He is no stranger to us, as he has attended our meetings in years past, and is upon our list of honorary members. Mr. Greenough has kindly consented to deliver to us words of welcome to the city of Cleveland and I now have the pleasure of calling upon him for that purpose.

ADDRESS OF WELCOME.

M. S. GREENOUGH.

Mr. President and Members of the Ohio Gas Light Association:

If all duties which have been assigned to me were as easy and as pleasant to perform as this one, life indeed would be very different. When Mr. McIlhenny sent me word yesterday that he would like to have me welcome the Ohio Gas Light Association to the city, it did not take a moment's consideration for me to accept with pleasure. It has been said, if felicitous conditions prevail and if you have the right spirit in your heart, then you have only to open your mouth and the words will run out without any effort on your part.

There are about 425,000 people in Cleveland at the present time. We all believe that the United States is the most progressive country in the world; that Ohio is the most progressive state in the United States, and Cleveland is beyond question the most progressive city in the state of Ohio. As one man of the 425,000 people I was delighted to know that the Ohio Gas Light Association was to meet with us, and it gives me the greatest pleasure to extend to you a hearty welcome to the city of Cleveland. The city is yours during your brief stay with us. We are called "The Forest City." We are very proud of our trees, our boulevards, our parks, our suburbs, and all that goes to make up the beauty of the city in the Spring and Summer. There are a good many points of interest in town. We have a fine assortment of elegant hotels. You will be interested to know that the police force in the city is very limited in number, and may not be able to cope with the unrestrained enthusiasm of so large a membership as the Ohio Gas Light Association possesses. You may also be interested in knowing that we have an extremely nice police station recently constructed and that it is very easy to get pardoned out of the workhouse.

There is but one piece of advice which I would like to give the Association. Do not drink any water. I know that the Association is anything but a "dry" one, but recognizing that you may have a tender spot in your heart towards water, I will remind you of a favorite quotation that "water is the woman of inanimate nature, versatile, fluent, lovely, untameable and dangerous." There is another quotation which may be apropos at the present time, and that is that a gentleman has been described as a man "who uses water with the utmost liberality on the outside and with the utmost parsimony on the inside." We are changing out water supply and the water which you would get at the hotels here might be better.

We will also be charmed to welcome you, while you are here, to the various gas plants in the city. There are two belonging to the company with which I am connected and I am led to believe, by the condition of the street in front of my door, that there is a natural gas company in town, which probably will be delighted to show you its gas pipe, and give you any other valuable information that you might desire.

I can truly say, I am glad that, in the cycle of events, you have concluded to come to Cleveland. In conclusion, let me, on behalf of the city of Cleveland, bid you all a most hearty welcome.

PRESIDENT McILHENNY:—I will ask F. W. Stone to respond to the address of welcome on behalf of our Association.

RESPONSE.

F. W. STONE.

Mr. President, Mr. Greenough and Members of the Ohio Gas Light Association:

It gives me a great deal of pleasure to respond, on behalf of the Association, to Mr. Greenough's words of welcome. It always gives one pleasure to be welcomed by old friends. If a man meets you at the door, and shakes hands with you and tells you he is glad to see you, you feel and appreciate it. If you come to a meeting like this and receive at the Gates of the City, cordial words of welcome, such as have been tendered by Mr. Greenough, you cannot help but appreciate it. There is a spirit of fraternity among us, and I am sure we all appreciate the sentiments expressed by Mr. Greenough and the hospitality extended by him on behalf of the city of Cleveland.

I do not think Mr. Greenough has any need to apologize for the condition in which we find the city at the present time, or the facilities for the entertainment of the Association, or anything of that kind. It is very seldom that an Association is afforded such opportunities of entertainment as are presented by the city of Cleveland. In a hotel, such as this, it is very seldom that an Association has the advantages of an assembly hall like the one we are now occupying. It is very seldom that an Association receives a more hearty welcome than has been accorded us here and we appreciate it. As Mr. Greenough has said, we want to be a little careful about drinking too much water while here. If you have a little hoarseness in your throat and a little dryness in your mouth, you can say that it was the cold breeze off the lake that did it; it would not be anything else I am sure.

On behalf of the Association, I wish to say we esteem it a pleasure to be entertained in Cleveland. We esteem it a pleasure to be here. We wish Mr. Greenough to feel that the Association comes here as friends of his, and that we feel he is a friend of ours, and in that way, as friends would meet friends, we want to meet him and to have him meet with us.

Speaking for the Ohio Gas Light Association, we return our earnest thanks to him and to the city of Cleveland for the cordial welcome extended to us on this our Twentieth Anniversary.

Upon motion the reading of the minutes was dispensed with which, being duly seconded, was unanimously adopted.

PRESIDENT McILHENNY:—The next order of business upon the program is the Report of the Executive Committee.

The Report of the Executive Committee was then read by Secretary Jones as follows:

REPORT OF THE EXECUTIVE COMMITTEE.

To the Members of the Ohio Gas Light Association:

GENTLEMEN:—Your Executive Committee begs leave to submit for your consideration the following recommendations and report:

First.—That M. E. Malone, Geo. Whysall and Frank Cavenagh be appointed a Nominating Committee.

Second.—That S. F. Hayward, Joseph Light and Ernest F. Lloyd be appointed a Committee on Memorials.

Third.—That W. E. Steinwedell, J. J. Knight and H. A. Carpenter be appointed a Committee on Next Place of Meeting.

Fourth.—That Eugene Printz, J. E. Stacey and George H. Tayler be appointed a Committee on Final Resolutions.

Fifth.—That John Read Miner, Howard Swartz, Edward Matt, George S. Dickey, William G. Sharp, E. M. Kerlin, D. M. Steward and J. W. R. Cline be released from membership at their own request.

Sixth—That H. E. Floyd, John B. Stevenson and B. F. Rothstein be dropped from membership for non-payment of dues.

Seventh.—That the following be elected to active membership:

New Members.

Abell, H. C., Engineering Assistant to Henry L. Doherty, Denver Gas and Electric Company, Denver, Colo.

Andrews, J. Chas., The Denver Gas and Electric Company, Denver, Colo.

Armstrong, F. S., Superintendent Macomb Electric Light and Gas Company, Macomb, Ill.

Arthur, W. A., Spencer Gas Company, Spencer, Mass.

Atwood, C. C., Engineering Assistant New Amsterdam Gas Company, Ravenswood, Long Island City, N. Y.

Auner, Harry, Superintendent London Gas Light Company, London, O.

Ayers, A. D., President Keokuk Gas Light and Coke Company, Keokuk, Ia.

Bacque, Louis H., Manager Three Rivers Gas Heat and Power Company, Three Rivers, Quebec, Can.

Baldwin, Wareham S., Superintendent Station B, Detroit City Gas Company, Detroit, Mich.

Bash, Henry C., Secretary and Treasurer Fayetteville Gas and Electric Company, Fayetteville, N. C.

Beadle, A. B., General Manager Peoples' Light, Heat and Power Company, 528 Bourse Building, Philadelphia, Pa.

Beal, A. B., Superintendent Newburg Light, Heat and Power Company, Newburg, N. Y.

Bell, Robert, Superintendent Fulton Fuel and Light Company, Fulton, N. Y.

Bigelow, Lucius Seymour, President The Light Publishing Company, 263 Broadway, New York City.

Bill, Benjamin P., Superintendent Capital City Gas Company, Montpelier, Vt.

Binkley, F. C., Superintendent Gas Appliance Department, The Turner Brass Works, Chicago, Ill.

Blanchard. Harry, Superintendent and Secretary Mendota Gas Company, Mendota, Ill.

Blinks, Walter M., General Gas Light Company, Kalamazoo, Mich.

Block, Barnhard, Special Representative Electric Oil and Gas Stove Works, 295 Pearl Street, New York City.

Boone, Chas., Engineering Assistant New Amsterdam Gas Company, Ravenswood, Long Island City, N. Y.

Brady, John T., Chief Clerk Denver Gas and Electric Company, Denver, Colo.

Brooks, F. F., Manager Charleston Gas and Electric Company, Charleston, Ill.

Brown, W. E., Manager New Westminster Gas Company, New Westminster, B. C.

Callanan, J. M., Superintendent Chester Branch, Suburban Gas Company of Philadelphia, Chester, Pa.

Cardall, J. H., Superintendent Huntsville Gas Company, Huntsville, Ala.

Cartwright, H. R., Manager American Meter Company, Arch and Twenty-second Streets, Philadelphia, Pa.

Chambers, R. J., Superintendent Montgomery Light and Water Power Company, Montgomery, Ala.

Chase, Louis, Salesman Liberty Mantle Manufacturing Company, Kinsic Street, Chicago, Ill.

Clark, Horace F., Salesman H. Mueller Manufacturing Company, Decatur, Ill.

Cochran, Horace J., Manager Maysville Gas Company, Maysville, Ky.

Collins, Warren, General Manager Sales Department, Stamford Gas Stove Company, Stamford, Conn.

Congdon, R. C., Manager Frederick Gas Company, Frederick, Maryland.

Cooper, William H., Superintendent Chuctanunda Gas Light Company, Amsterdam, N. Y.

Copley, I. C., General Manager Fox River Light, Heat and Power Company, Aurora, Ill.

Cowdery, E. G., Vice President and General Manager The Laclede Gas Light Company, St. Louis, Mo.

Cowperthwait, B. W., Secretary and Treasurer The Faribault Gas and Electric Company, Faribault, Minn.

Cressey, Frank A., Jr., Manager Modesto Gas Light, Coal and Coke Company, Modesto, Cal.

Cressler, Alford M., Treasurer Kerr Murray Manufacturing Company, Fort Wayne, Ind.

Cressler, Geo. H., Secretary Kerr Murray Manufacturing Company, Fort Wayne, Ind.

Cross, Philip, Manager N. B. Department, Denver Gas and Electric Company, Denver, Colo.

Cullinane, J. R., Secretary and Superintendent Denison Light and Power Company, Denison, Tex.

Curtis, S. P., General Superintendent American Gas Company, Philadelphia, Pa.

Dales, J. M., Superintendent Electrical Department Lincoln Gas and Electric Company, Lincoln, Neb.

Daley, Edward M., Inspector and Assistant Superintendent Haverhill Gas Light Company, Haverhill, Mass.

Daly, Martin B., General Manager East Ohio and N. W. Ohio Gas Company, Cleveland, O.

Daniels, J. M., Agent and Superintendent Columbia Gas Light Company, Columbia, S. C.

Davis, C. R., Secretary and Treasurer Noblesville Gas and Improvement Company, Noblesville, Ind.

Davis, Ernest H., Treasurer Lewistown Gas Light, Heat and Power Company of Lewistown, Williamsport, Penn.

Davis, S. S., Secretary Peoples Power Company, Moline, Ill.

Dewey, V. F., Assistant Superintendent Manufacturing Detroit City Gas Company, Detroit, Mich.

Dickerson, James N., Manager and Engineer Citizens Gas and Fuel Company, Dunkirk, N. Y.

Dixon, Junius S., Superintendent Gas Manufacturing Utica Gas and Electric Company, Utica, N. Y.

Dole, H. N. P., Engineer Columbus Light and Heating Company, Columbus, O.

Doty, Paul, Vice President and General Manager Denver Gas and Electric Company, Denver, Colo.

Eustace, E. W., Superintendent Gas Department Peoria Gas and Electric Company, Peoria, Ill.

Eyman, L. E., President and Treasurer Pueblo Gas and Fuel Company, Pueblo, Colo.

Faller, G. W., Superintendent Distribution Madison Gas and Electric Company, Madison, Wis.

Ferguson, B. B., Superintendent Portsmouth Gas Company, Portsmouth, Va.

Field, R. A., Superintendent The Rome Gas, Electric Light and Power Company, Rome, N. Y.

Frueauff, F. W., Secretary Denver Gas and Electric Company, Denver, Colo.

Frost, William H., General Manager Detroit Gas Light and Coke Company, Delray, Mich.

Funkhouser, E. M., President Staunton Gas Company, Staunton, Va.

Ganser, H. H., Superintendent Gas Company of Montgomery County, Norristown, Pa.

Garard, J. W., President and General Manager The Ohio Fuel Supply Company and The Federal Gas and Fuel Company, Columbus, O.

Gillette, J. Walter, General Manager Consolidated Schuylkill Gas Company, Phœnixville, Pa.

Gould, Vernon K., Superintendent Bangor Gas Light Company, Bangor, Me.

Graf, Carl H., General Superintendent J. T. Lynn Company, 402 Union Trust Building, Detroit, Mich.

Hagerty, J. H., Superintendent American Illuminating and Power Company, Americus, Ga.

Hague, W., Superintendent Forest Gas Company, Tidioute, Pa.

Hall, Andrew F., Superintendent and General Manager Southbridge Gas and Electric Company, Southbridge, Mass.

Haines, Jansen, Manager Capital City Gas Light Company, Des Moines, Ia.

Hammon, W. H., Assistant General Manager Union National Gas Corporation, Ruggery Building, Columbus, O.

Hemenway, W. E., Superintendent Warsaw Gas and Electric Company, Warsaw, N. Y.

Hendley, Jos. L., Manager Beloit Gas Light and Coke Company, Beloit, Wis.

Hibberd, E. G., Secretary and Treasurer Richmond Natural Gas Company, Richmond, Ind.

Hicks, Geo. C., Jr., Engineer P. H. & F. M. Roots Company, Connersville, Ind.

Highlands, E. M., Superintendent Clinton Gas Light and Coke Company, Clinton, Ia.

Hilleke, A. F., Superintendent United Coke and Gas Company, Glassport, Pa.

Himsworth, Hines H., Assistant to Superintendent of Gas Department, Denver Gas and Electric Company, Denver, Colo.

Hodgson, John A., Superintendent The Athens Gas Company, Athens, Ga.

Hoffman, R. J., President Hoffman Natural Gas Company, Bradford, Pa.

Howard, Chas. A., President Aberdeen Gas Company, Aberdeen, S. D.

Hughey, W. C., Superintendent Sales Denver Gas and Electric Company, Denver, Colo.

Humphreys, H. S., Manager and Secretary Humphrey Company, Kalamazoo, Mich.

Hyde, Henry H., Secretary and Manager Racine Gas Light Company, 305 Sixth Street, Racine, Wis.

Jelliffe, C. N., Auditor American Light and Traction Company, 40 Wall Street, New York.

Johns, L. B., Superintendent Dedham and Hyde Park Gas and Electric Light Company, Hyde Park, Mass.

Johnson, J. M., Foreman Shops and Works, Durham Light and Power Company, Durham, N. C.

Jones, Philo, Superintendent at Salinas, Monterey County Gas and Electric Company, Salinas, Cal.

Kempf, John, Jr., Superintendent Gas Service, Utah Light and Railway Company, Salt Lake City, Utah.

Keutz, J. C., Storekeeper Dayton Gas and Fuel Company, Dayton, O.

Kirk, F. M., Wholesale Coal, Kirk-Woods Coal Company, Cleveland, O.

Klein, B. F., Gas Fixture and Brass Company, Sheriff and High Streets, Cleveland, O.

Koiner, C. W., Superintendent Madison County Gas and Electric Company, Oneida, N. Y.

Latta, M. Nisbet, Superintendent Charlotte Electric Railroad and Power Company, Charlotte, N. C.

Law, A. R., General Manager and Superintendent Durham Light and Power Company, Durham, N. C.

Lawlor, R. H., Superintendent Michigan City and Northern Indiana Gas Company, Michigan City, Ind.

LeBaron, L. W., Superintendent Gas Plant, Albuquerque, N. M.

Letang, B. E., Proprietor Jackson Gas Light Company, Jackson, Cal.

Lindsey, E. C., Superintendent The Ravenna Gas and Electric Light Company, Ravenna, O.

Lord, R. S., Manager The Hammon Coupler Company, Pittsburg, Pa.

McCallum, J. N., Auditor Michigan City and Northern Indiana Gas Company, Michigan City, Ind.

McDonald, Albert, Superintendent Metric Metal Works, Erie, Pa.

McGraw, F. J., Manager Downington Gas Company, Downington, Pa.

McIlhenny, Francis S., President Peoples Gas Company of Pottstown, 1001 Chestnut Street, Philadelphia, Pa.

McLean, Geo., President and Manager Key City Gas Company, Dubuque, Ia.

McMahon, J. W., Superintendent The Northwestern Ohio Natural Gas Company, Toledo, O.

MacMillan, Geo., Vice President, Treasurer and General Manager La Crosse Gas and Electric Company, 222 Main Street, La Crosse, Wis.

Madden, James, Foreman Greenville Gas Company, Greenville, Pa.

Magee, Robert S., Traveling Salesman Kanawha Fuel Company, Cincinnati, O.

Mann, Howard E., Superintendent Works No. 2, Cleveland Gas Light and Coke Company, Cleveland, O.

Marks, R. J., Manager Lexington Gas Company, Lexington, Ky.

Martin, Freeman Drake, Superintendent and Treasurer Ft. Scott Gas and Electric Company, Ft. Scott, Kan.

Mayer, John L., Superintendent Hazleton Gas Light Company, Hazleton, Pa.

Mayer, Jos., Superintendent Lakewood Gas Company, Lakewood, N. J.

Miller, C. O. G., President Pacific Lighting Company, San Francisco, Cal.

Miller, R. W., Superintendent Conneaut Gas Light and Fuel Company, Conneaut, O.

Miller, W. H., Superintendent Bangor Gas Company, Bangor, Pa.

Moore, Edwin, President American Coke and Gas Consolidated Company, Camden, N. J.

Morris, Daniel, Secretary and Superintendent Greenville Gas Light Company, Greenville, O.

Morris, W. Cullen, Engineer New Amsterdam Gas Company, Ravenswood, Long Island City, N. Y.

Motley, Geo. L., President Lowell Gas Light Company, Lowell, Mass.

Nettleton, Charles H., New Haven Gas Light Company, New Haven, Conn.

Osbourne, E. M., Superintendent Light and Fuel Company, Valparaiso, Ind.

Owens, H. G., Superintendent The Coshocton Gas Company, Coshocton, O.

Payne, A. L., Manager and Secretary Nelson Coke and Gas Company, Nelson, B. C.

Payne, Frank H., Manager Metric Metal Works, Erie, Pa.

Pearson, John R., Assistant to President Indianapolis Gas Company, Indianapolis, Ind.

Pelton, B. F., Superintendent Gas Department Cheyenne Light, Fuel and Power Company, Cheyenne, Wyo.

Pennoyer, C. H., Secretary and Manager United Gas and Electric Company, San Jose, Cal.

Pew, John Glenn, Assistant Manager Peoples Gas Company, Pittsburg, Pa.

Pinkney, E. A., Superintendent Sag Harbor Lighting Company, Sag Harbor, N. Y.

Plummer, H. W., Secretary Asheville Electric Company, Asheville, N. C.

Porter, Jos. F., President and Treasurer Alton Light and Traction Company, Alton, Ill.

Power, John J., Superintendent Cumberland Gas Light Company, Cumberland, Md.

Powers, Edgar F., Secretary Consolidated Gas Company of Baltimore City, Baltimore, Md.

Pratt, Edward G., Vice President and General Manager Milwaukee Gas Light Company, Milwaukee, Wis.

Price, Charles R., Treasurer New Bedford Gas and Edison Light Company, New Bedford, Mass.

Purcell, Theo. V., General Manager Ogden Gas Company, Chicago, Ill.

Quackenbush, Chas. H., Superintendent Gas Department Merion & Radnor Gas and Electric Company, Ardmore, Pa.

Reitmeyer, A. F., Superintendent, Secretary and Treasurer Perth Amboy Gas Light Company, Perth Amboy, N. J.

Rettew, C. H., Superintendent Selma Lighting Company, Selma, Ala.

Richards, F. M., Superintendent Stations, Madison Gas and Electric Company, Madison, Wis.

Richardson, W. W., General Superintendent East Ohio Gas Company, Cleveland, O.

Ritschy, L. J., Assistant Superintendent Laclede Gas Light Company, St. Louis, Mo.

Robb, J. M., Chief Clerk Peoria Gas and Electric Company, Peoria, Ill.

Roohan, Patrick, Superintendent Saratoga Gas and Electric Light Power Company, Saratoga Springs, N. Y.

Ross, J. Chas., General Manager Steubenville Traction and Light Co., Steubenville, O.

Ross, W. H., Superintendent Bowling Green Gas Company, Bowling Green, O.

Roycroft, Thomas, Superintendent Grand Forks Gas and Electric Company, Grand Forks, N. D.

Savage, Geo., Engineer Works, Suburban Gas Company, Chester, Pa.

Schmidt, Emil G., General Manager Springfield Gas Light Company, Springfield, Ill.

Schnierle, E. H., Superintendent Salem Gas Light Company, Salem, O.

Scott, G. C., Secretary and Superintendent Central Ohio Natural Gas and Fuel Company, Columbus, O.

Shaw, Herbert S., Treasurer and Superintendent Webster Electric Company, Webster, Mass.

Sherwood, E. J., Superintendent Gas Department Lincoln Gas and Electric Company, Lincoln, Neb.

Sites, Wm. M., Statistician Denver Gas and Electric Company, Denver, Colo.

Slater, A. B., Jr., Engineer Western Gas Construction Company, Fort Wayne, Ind.

Sloper, A. T., Secretary New Britain Gas Light Company, New Britain, Conn.

Smith, Ernest B., Secretary The Coshocton Gas Company, Coshocton, O.

Smith, Arthur M., Treasurer The Gas Machinery Company, Cleveland, O.

Smith, Arthur C., Secretary and Treasurer Valparaiso Light and Fuel Company, Valparaiso, Ind.

Speer, R. I., Manager Pulaski Gas Light Company, Little Rock, Ark.

Starr, Howard W., Engineer Mohawk Gas Company, Schenectady, N. Y.

Stiles, Aaron K., President Streator Gas and Light Company, Streator, Ill.

Sullivan, R. B., Assistant Treasurer The Denver Gas and Electric Company, Denver, Colo.

Summers, T. W., Manager Ithaca Gas Light Company, Ithaca, N. Y.

Thomas, Chas. G. M., Vice President and General Manager Newtown and Flushing Gas Company, Flushing, N. Y.

Thompson, Herbert W., Purchasing Agent, Denver Gas and Electric Company, Denver, Colo.

Thompson, F. DeV., General Manager Springfield Gas Light Company, Springfield, Mass.

Tippy, B. O., Superintendent Manufacturing Detroit City Gas Company, Detroit, Mich.

Tracey, Walter B., Traveling Salesman Spang Chalfant Company, Pittsburg, Pa.

Travis, Frank M., Treasurer New Haven Gas Light Company, New Haven, Conn.

Tuttle, W. B., General Manager Consolidated Gas Company of New Jersey, Long Branch, N. J.

Uteck, Clarence, Foreman Gas Works, Streator Gas and Light Company, Streator, Ill.

Vance, J. C., Superintendent Hazelwood Gas Company, 1109 Madison Avenue, Anderson, Ind.

Walker, W. L., Superintendent Gas Department Fitchburg Gas and Electric Co., Fitchburg, Mass.

Watts, Chas. L., Local Manager Logan Natural Gas and Fuel Company, Ashland, O.

Weber, E. S., Superintendent Gas, Heat and Power Company, Mechanicsburg, Pa.

West, Geo. M., Superintendent Standard Gas Company, Danville, Pa.

Whipple, Henry S., Superintendent Rockford Gas Light and Coke Company, Rockford, Ill.

Wilkin, John T., Engineer Connersville Blower Company, Connersville, Ind.

Williams, C. H., General Superintendent Madison Gas and Electric Company, Madison, Wis.

Wilson, Edward F., Chemist Westmoreland Coal Company, Irwin, Pa.

Wolff, S. E., Secretary and General Manager Jackson Gas Company, Jackson, Mich.

Woodward, Ralph, General Manager Pittsfield Coal Gas Co., Pittsfield, Mass.

Woolcott, H., Secretary Consolidated Railways, Light and Power Company, Wilmington, N. C.

Wyness, Alex., Jr., Superintendent and Secretary Geneseo Gas Light Company, Geneseo, N. Y.

Yokum, Winfield H., Suburban Gas Company of Philadelphia, Media, Del. Co., Pa.

Respectfully submitted for the Executive Committee,

T. C. JONES, Secretary.

PRESIDENT McILHENNY:—This makes a total of 188 applications for membership. It is certainly a most gratifying addition to our roll of membership, and I am quite sure that it is the largest roll of new members which has ever been received by any gas association. It will add much to the interest to be taken in this meeting, and will, no doubt, give the old membership the advantage of a much wider field of information, and prove a source of profit, not only to the members in attendance at this meeting, but also to the gas companies generally. I think it is also proper for me to say that the credit which we should give for this large acquisition to our membership is due mainly to our worthy and efficient Secretary and to Mr. Henry L. Doherty, of Denver, Colorado.

PRESIDENT McILHENNY:—Gentlemen, you have heard read the report of the Executive Committee. What is your pleasure?

On motion of F. W. Stone, duly seconded and carried, the report of the Executive Committee was adopted and ordered spread on the minutes of the Association.

Election of New Members.

It was then moved by Mr. Irvin Butterworth, of Detroit, Mich., duly seconded and carried, that the Secretary cast the ballot of the Association for the election to membership in the Association of the applicants recommended by the Executive Committee in its report, as above adopted.

SECRETARY JONES:—Mr. President and gentlemen, complying with your directions, as contained in the motion just adopted, it gives me pleasure to cast the ballot of the Association for the election to membership of the applicants referred to in the report of the Executive Committee. I hereby so cast the ballot of the Association and do declare them all duly elected to membership in the Ohio Gas Light Association.

PRESIDENT McILHENNY:—Of course it is understood that the gentlemen whose applications have just been favorably acted upon and who are now members of the Ohio Gas Light Association, are at liberty to participate in these proceedings, and we would be glad to hear from them in the discussions which are to follow. The next report in order is the report of the Secretary and Treasurer.

T. C. Jones, of Delaware, Ohio, then submitted the following report:

REPORT OF SECRETARY AND TREASURER.

To the Members of the Ohio Gas Light Association:

GENTLEMEN :—I have the honor to present herewith the twentieth annual report of the Secretary and Treasurer for the period between March 18, 1903, and March 16, 1904:

New Members admitted at the nineteenth annual meeting...	32
Released from membership	15
Deaths	4
Active members this date	241
Honorary members this date	9

Financial Report.—Receipts.

Balance from last year	$509 85
Received from dues	681 00
Received from initiations	155 00
Received from gas journals for report of nineteenth annual meeting	174 90
Total	$1,520 75

Expenditures.

Printing and stationery	$236 31
Postage	51 70
Expense reporting nineteenth annual meeting........	174 90
Secretary's salary	300 00
Expense of Executive Committee	14 50
Telegrams and telephones	2 92
Express	11 55
Badges	18 00
Balance on hand as per certified check	710 87
Total	$1,520 75

Respectfully submitted,

T. C. JONES, Secretary and Treasurer.

Approved: F. W. STONE, C. A. SCHWARM.

It was duly moved, seconded and carried, that the report of the Secretary and Treasurer be received, adopted and ordered spread upon the minutes of the Association.

President McIlhenny:—We have received quite a number of letters of regret from persons not able to attend the meeting, and I will call upon the Secretary to read their names.

Letters of Regret.

Secretary Jones:—Gentlemen, the following is a list of the letters and telegrams of regret from those who could not be present upon this, our Twentieth Anniversary:

Walter R. Addicks, C. W. Andrews, E. C. Brown, Alfred E. Forstall, John Franklin, J. B. Grimwood, A. C. Humphreys, C. M. Higgins, John P. Harbison, A. P. Lathrop, Rollin Norris, George G. Ramsdall, J. D. Shattuck, F. H. Shelton, Wm. Henry White and James W. Dunbar.

Vice President Stone then assumed the President's chair and John Dexter McIlhenny delivered the following:

PRESIDENT'S ADDRESS.

JOHN D. M'ILHENNY.

It is my agreeable duty to chronicle a year of advancement for the Ohio Gas Light Association. Imbued with a spirit of helpfulness, this Association is contributing largely to the welfare of the gas industry and of those connected with it. While primarily a state organization, its vigor and practical character have attracted to it many from outside the state of its birth. To all a warm welcome is extended.

In the work of associations, committees constitute an effective means of accomplishing results, the requisites on the part of the members being ability and willingness to serve. With the greatest pleasure, I commend the committees of the Association for the energy and zeal displayed by them, and for the satisfactory results produced.

The editors of the different departments have unselfishly devoted their time and talent to the Association and the dissemination of knowledge. Much honor is due them.

The Ohio Association can truly be proud of its achievements. The utmost usefulness, however, of gas associations has not yet been found. More should be done for the members throughout the year. Problems arise, often of minor character, but difficult of solution, particularly in isolated locations, and help at the time would be most valuable. I suggest, therefore, as a step toward greater usefulness, that a Bureau of Information be created which may be called upon by the members at any time. The editor of the bureau could have assistants in each department of the profession to whom inquiries could be referred.

The Association this year publishes its first volume of proceedings, covering the three years just past. The issuance of a new volume each year is contemplated, in order gradually to embrace all the proceedings. The task of indexing and preparing the book was undertaken by Mr. T. C. Jones, Secretary of the Association, as a labor of love, and he is entitled to our gratitude.

While the Association has been so prosperous during the year it has, nevertheless, felt the hand of the "Grim Reaper" in four deaths among our members. The names of three honorary members can no longer grace our rolls:

William A. Stedman, of Brooklyn N. Y., died Sunday, November 8, 1903.

Eugene Vanderpool, of Newark, N. J., died July 12, 1903.

Asa S. Bushnell, of Springfield, Ohio, died January 15, 1904.

From our active members we have lost Burgess L. McElroy, of Mt. Vernon, Ohio, who died Sunday, June 28, 1903.

As is customary, a special committee of the Association will prepare minutes for record in our official proceedings.

I can report to you a satisfactory condition in general of the gas business. It is being developed thoughtfully and intelligently. In manufacture, the value of small economics is especially appreciated. High pressure confers valuable assistance in difficult problems of distribution, and its application will steadily advance.

Uses for gas unfold constantly and outputs steadily advance, though in no case has the maximum possibly been attained. The goal of 10,000 cubic feet per capita per annum in the United States has already been passed. The campaign for increase along well known fuel lines continues, and more attention is being given to the lighting field, which, for a time, was partially overlooked. Economical burners and attractive lamps are at our disposal, and we must remember that each additional outlet gained adds to the value of our plant.

The sale of gas for industrial purposes offers alluring opportunities, and is a most desirable field now opening for gas companies. It has a particular advantage, since the gas is used continuously, as a rule, many hours of the day and throughout the year. This class of consumption, from its evenness of load, is most profitable, and gas companies can afford to offer extraordinary inducements for its cultivation. Appliances can now be obtained for nearly all purposes of which heat is an element, permitting the employment of gas in many ways heretofore thought impracticable.

The surroundings of some of us may be less fortunate than others, but they who consider their environment discouraging should take heart. There is always a best possible result in every situation. Eagerness for credit often handicaps our efforts. Benjamin Franklin, the practical man of affairs and sage philosopher, in his autobiography states that he always preferred to remain in the background, and eventually he was found to be the real power, obtaining credit for even more than he deserved.

We are engaged in no mean occupation, and can well be proud of our calling. It demands qualities worthy of men—fidelity, diligence and ability, with capacity to control events and direct movements. Gas was first made and sold for light 100 years ago. To-day it makes day of night and dark places light, it has relieved womankind of drudgery, and is a servitor of good not equalled by any other commodity in the civilized world.

It was moved by Mr. Sterling F. Hayward, of New York City, duly seconded and carried, that the address of the President be referred to a committee of three to be appointed by Vice President Stone, who then appointed the following: Messrs. Irvin Butterworth, Detroit, Mich.; Isaac C. Baxter, Detroit, Mich., and G. N. Clapp, Middletown, O.

John D. McIlhenny, resuming the President's chair, said: We will next proceed with the reading of papers in accordance with the printed program. I will first call upon Mr. Knight.

HIGH-PRESSURE GAS IN STREET LIGHTING.

J. J. KNIGHT.

All things considered, the most efficient, satisfactory, and, therefore, most generally adopted street lighting system in use to-day is probably that furnished by the use of the so-called 2,000 candle-power open electric arc lamps, hung from 20 to 30 feet from the ground, and in the center of the street intersections, the long way of the block, and alternate intersections the long way of the block, and alternate intersections the short way of the block.

The lamps so placed are usually about 500 feet apart, except in what may be called the police districts, where they are placed somewhat closer.

A better system, except for the matter of expense, would be the use of the inclosed electric arc lamps placed—say, 200 feet apart on alternating sides of the street, hung from 12 to 15 feet high.

There may be earnest gas men who will not agreee with these statements, and who believe that single-mantle gas lamps of the modern type placed at short intervals are more satisfactory.

It is possible that such would be the case if they were frequent enough, were well maintained, and were not subject to disability and amage from frost, wind, bugs, etc., and the cost of installation, operation and maintenance did not exceed the cost of electricity.

I am quite sure as a general proposition, the electric light is more favorably regarded by the average citizen not interested in gas, and it is probably not wise to let our enthusiasm lead us astray in this matter, as T. D. Miller said at the American meeting: "It will not do to fool ourselves."

We are all familiar with the many objections to the electric street light, with its frequent outages, great variation in average spherical and maximum candle-power, heavy shadows, lack of volume of light, objectionable and dangerous line construction, etc., and it would certainly be greatly to the advantage of the business we represent if a system of lighting streets with gas could be devised, which would overcome the objectionable features of all the present systems, and at the same time supply what has been said to be the first consideration in any system of street lighting, viz.: to give the public the impression of well-lighted streets at a small or reasonable cost.

There is no doubt there exists a demand for this, a sort of underground growl, which goes along with the general belief that there is nothing better, but let something better appear and this demand will burst into a clamor at once.

Ever since Mr. Shelton surprised us all by his paper on "High-Pressure Gas," read at the Western meeting, held at Wilwaukee, some time ago, it has seemed to me that in some way we should solve the question of ideal street lighting by this means, and during the last year and a half I have given the subject much thought, made many experiments, and, I am frank to confess, met with some severe disappointments and surprises, not the least of which was within the last few weeks, and which was in the nature of a telephone message to our Mr. Blinks from Hammond, Ind., where high-pressure distribution is being used, and which stated that their experience there this winter had not borne out their previous experience or the opinions held and expressed by their Mr. Goodnow, of Waukegan, viz.: that high pressure eliminates troubles from moisture and frost.

The Hammond Company is operated by what is known as the Dawes syndicate, who have done more with high-pressure distribution than any other operators of whom I have any knowledge, and who have it in use, delivering gas directly to the consumers at Waukegan, Hammond, Chicago Heights and Blue Island, and at other points for use in reinforcing low-pressure mains.

On receipt of this information our Mr. Blinks visited Hammond and found that a number of services which had been laid without regard to grade have given endless trouble, and it was said all these would have to be relaid.

I then wrote Mr. Goodnow, asking if he had any explanation of this or if he had changed his mind. Up to the date of writing this I have not heard from him, which is due, I think, to his absence from home. I assume, however, that there is some explanation, and trust that Mr. Goodnow or some other member will be at the meeting, able to give us the interpretation of the trouble.

Considering, therefore, the possible undeveloped difficulties with high-pressure gas, and but partially developed plans for the street equipment, I feel, as I wrote our Secretary, Mr. Jones, when he asked me to say something on this subject, that there is so much I know but little about with certainty, so little that I know all about with certainty, and so much I probably know nothing about, I have prepared this short paper with a good deal of reluctance.

I have, however, determined some things, and the weight of my observation and experience justify me in the belief that we will be able to again light streets with gas far better, and at least at no greater cost for operation than is now being done with electricity, and that the most important factor will be the use of high pressure distribution.

In order that attention may be drawn to the subject and discussion aroused, I will say that in my judgment the method will be worked out on about the following lines: In cities, up to, say 25 to 30,000 people, the distribution system will consist of 1-inch to 1¼-inch services, radiating from a central station, to which the gas, after having been metered, will be piped from the gas works in a large main and under high pressure.

Each service will supply lamps on, say, two miles of street. They will be laid very shallow and inside the curb except where they cross the streets. The posts will be ornamental and attractive in appearance, and will be placed on alternating sides of the streets, about 300 feet apart.

The lamps will also be ornamental in appearance, of high candle-power, equipped with metal antivibrators, and scientifically designed reflectors. They will hang suspended slightly out from the post, and about 12 feet from the ground on the ordinary 66-foot street. They will probably be three mantle lamps. They will have to be so constructed as to be wind proof, not affected by the elements, and able to resist very high temperatures (one of the most difficult problems in connection with the wind-proof lamps operating on high-pressure gas).

The gas will be turned on and off from the lamps at the central station by means of the pressure, which, when the lamps are not in use, will be normal.

The lighting will be accomplished by the use of pilots, which will burn constantly a small amount of gas. To maintain this pilot at a uniform consumption of gas is another difficult problem, and may possibly require another and smaller service, though I think not. In any case, the cost would not be excessive and would not much exceed the bare cost of the pipe.

The services will probably be laid in tar concrete and boxed and will be practically everlasting.

I have given you the details of the lamp construction as fully as I can at this moment, and in its present state of development. By attempting to be more explicit I might mislead others who may have worked or may hereafter work along these same lines, but I can say with confidence, I think, that the lamps will not have any hot air engines or very long chimneys connected with them, as I believe I have demonstrated the impracticability of these, at least to my own satisfaction.

What has been said completes the plant for cities of the class mentioned. For larger cities, larger services or more stations will be provided, according to the economies in the case.

Considering the comparative costs of construction, I estimate that the services, posts and lamps will cost about 30 per cent. more than the line, pole and lamp construction of the electric system.

The cost of maintenance and attendance will be very materially less. I think the whole cost of operation, including the gas, will enable gas companies to make 10 to 15 year contracts to install the plant and operate it at a price for light not exceeding the costs of light which are now made by the best managed municipality-operated electric plants, and at this price get back the cost of the plant and a satisfactory profit on the gas during the life of the contract.

The contract will provide for extensions of the plant from time to time at the city's expense during the term of the contract, and at its expiration the plant will become the property of the city in case a further long contract is made for a supply of gas by the company at reasonable rates.

The advantages of this system of lighting can scarcely be estimated. Services under ground, out of sight and safe in place of dangerous and obstructive wires, attractive iron posts instead of unsightly and short-lived wooden poles, the light uniform, constant, and of an efficiency never approached heretofore, and by a system so flexible that it will be possible to operate it on the moon-light schedule, and have light at a moment's notice whenever needed, and at the same time realize all the economies possible in the case, a thing which is wholly impractical with the electric system.

High-pressure distribution will be the most important factor in the operating of this system. I depend upon it for eliminating the frost problem, for cheapening the cost for construction, for the turning on and off at a central point, and so far as it is important, in giving light efficiency. I am so confident of its success that I am going to ask the city of Kalamazoo to allow me to light a street as soon as I am satisfied with my lamp construction.

The city is now operating its own electric plant, and I believe it is the best and most economically lighted city with which I am familiar, and yet the City Council have within a short time submitted to a vote of the citizens a proposition to abandon its plant and contract with a private corporation, this before the bonds were paid which were issued to install it, and the proposition would have carried if the bidding company had made any kind of a decent offer to take over the plant, but they made none, and even we, who are most opposed to municipal ownership, were obliged to vote against the proposition in self-defense, as taxpayers, as we could not stand for a total depreciation within less than 10 years. If I can meet their costs as easily as I can excel their light efficiency I shall indeed be gratified.

Mr. Knight:—In this paper I refer to the fact that I wrote Mr. Goodnow, asking if he had any explanation as to the trouble encountered by his company at Hammond, stating that I did not receive a reply. I wish to state that since this paper was prepared I have heard from Mr. Goodnow and Mr. Johnson. Mr. Johnson is the manger at Hammond. They stated that they had concluded that they had not made the proper arrangement for taking out the moisture after compression at the works and they thought they would not have had any trouble if they had done so.

DISCUSSION.

President McIlhenny:—The paper just read is one of the newer topics in the gas business, and we would be glad to have a full discussion. We want everybody to understand that each and every one is entitled to the floor, the new members as well as the old.

Mr. C. A. Schwarm, Hornellsville, N. Y.:—I would like to ask Mr. Knight, if in his experiments, whether he found that the three-mantle lamp burning under high pressure would give as much light as one of the later types of inclosed arc lights? He refers particularly to nominal 2,000 candle-power open electric arc. It is generally considered now, I believe, in the street lighting field that the inclosed arc lamp is superior, and I would like to ask if his experiments were based on a competitive test with either the open arc or the inclosed arc? Of course, if we attempt to place gas arcs before the public, we should at least equal the expense of the electric arc, and also be able to furnish the same amount of light. It is a question in my mind whether the three-mantle burner would give the same light as the inclosed arc of the alternating type.

Mr. Knight:—I think that the three-mantle lamp distributed as I have suggested, will give a better light for street lighting purposes than any electric arc. In my experiments I have compared it with the open arc, because my understanding is that they are a much stronger light than the inclosed arc. That is to say, I understand that the inclosed electric light loses about 40 per cent. of its light by being inclosed. That has been my experience with any of those that I know anything about.

Mr. Schwarm:—I should say, Mr. President, that I think any experiments on that line should be made in comparison with the inclosed type of arc light to-day, because the inclosed type is rapidly displacing the open arcs on account of cost of operation and the expense incident thereto. The question of the superiority of a light, as between the open and the closed arc, is an open one in the electrical business, but inasmuch as the inclosed arc is becoming more popular every year I think the comparison should be made on that basis.

Mr. D. R. Warmington, Cleveland, O.:—I would like to ask Mr. Knight how much pressure he carries when he speaks in his paper of a high-pressure line? What pressure did you have on the burner?

Mr. Knight:—I do not get an increased light efficiency through an increase of pressure above 5 or 6 inches at the burner. Of course, we carry a much higher pressure on the line.

President McIlhenny:—The system of high-pressure lighting has advanced much more in Europe than it has here. I believe, in Manchester, England, there is a system of high-pressure lighting which is giving very satisfactory results. Mr. Doherty, have you anything to say on this subject?

Mr. Henry L. Doherty, New York City:—I do not know that I have anything to say, Mr. McIlhenny, on this subject except that I for one would like to encourage Mr. Knight to continue his experiments. He is working along a most promising line, to my mind, in the development of gas street lighting. I believe high pressure for mantle lighting makes the efficiency of the lamps sufficient to compete with any of the present forms of electric street lighting. I was rather interested in the discussion between Mr. Knight and Mr. Schwarm regarding the inclosed and open arc systems of street lighting. Mr. Schwarm spoke of the fact that the inclosed arc lamp is rapidly superseding the open lamp. It is doing that, in spite of the fact that the total light, per watt consumed is much less. If you want to get positive data on that subject you will find it in the procedings of the National Electric

Light Association in three, four or five reports of the Committee on Arc Lamp Photometry. These reports are standard the world over now, and you can get figures that would be safe and accurate for comparison with gas lamps or any other form of illumination. I think you will have a greater competition from other forms of electric street lighting than from the inclosed arc lamps, and that we ought to keep in mind the fact that we have to do something better than to beat the inclosed arc lamp. The series open arc lamp, were it to be operated upside down, with a properly designed reflector, would to my mind, undoubtedly give very much better results than could be secured by the inclosed arc lamps. I think, in spite of the fact that the Nernst lamp does not give as high an efficiency as is ordinarily claimed by the manufacturers of the lamp when considered as a source of light in every direction from the lamp, it can be used in smaller units, and as the light decreases in reverse ratio to the square of the distance, the minimum illumination is, perhaps, greater for the same consumption of watts than any form of arc lighting, even though the total flux of light is less. The Cooper-Hewitt Mercury Vapor Lamp, I believe, is the most promising lamp for street lighting at present. But if I was competing for a street lighting system myself, I think I would prefer to use some system of smaller units, either the Nernst lamp or something of that sort in preference to the inclosed arc lamps, and I would be much inclined to the Cooper-Hewitt Mercury Vapor Lamp for street lighting purposes. We have to do something better than compete with the inclosed arc lamp, and while we are able to secure a great deal of street lighting with the ordinary incandescent gas lamp, we may have a harder time to do that in the future, unless we increase the efficiency of the incandescent gas lamp. Therefore, perhaps, Mr. Knight is doing better work for the gas fraternity than any one of us appreciates just now.

MR. STONE:—One bright spot in Mt. Knight's paper to my mind was the idea of independent control of his street lighting, regardless of the distribution of gas for other purposes. I have thought some about entering into competition with electrical companies for lighting streets by gas. In fact, not more than a year or so ago, I bid against an electrical light company for the privilege of lighting the streets of our city. I did not succeed simply because of the glamor that there is surrounding electric street lighting. For some reason, and you know it as well as I do, the people as a whole think that electric lighting is better than gas for street lighting purposes. While you might make a proposition that would be cheaper it would be hard to convince the people of that fact and you have to make it so much cheaper and present its advantages in such a way that it will leave no possibility of doubt along that line. One of the causes which has operated against a gas company competing for street lighting, especially where the streets cover considerable territory, was the idea that you had to go around and light every lamp separately and have a gas lamp lighter, and if you wanted to operate on a moonlight schedule you would have to call your man out at almost all hours of the night in order to do it. For that reason Mr. Knight's paper has interested me very much. Now with all gas men it finally comes down to the question whether or not it pays. If you figure that you can get a contract for 10 or 15 years, you have to put a separate plant in for the carrying out of the contract and you have to figure that your plant will be of no use to you for anything else at the end of that period. You have to allow for that in your estimate of cost. Then it is somewhat of a question with me whether the mantles and the apparatus required in high-pressure street lighting do not depreciate more per light unit or per candle-power or per cost of unit in operation than they do in low-pressure lamps. I know that a mantle working on 4 ounces, which is about 7 inches pressure, with natural gas depreciates much more rapidly than a mantle working on 2 or 3 inches pressure with artificial gas. The heat is more intense and the mantle gives out more,quickly and the rest of the lamp burns out more rapidly. There is a question whether the cost of maintenance of a high-pressure lamp would not more than offset the increased efficiency of the lamp. These are all questions in my mind which should be worked out from actual experience. I am sure we are all glad to have Mr. Knight work them out and we would all be very much pleased if he could demonstrate it to be a practicable success. As I said before, I think the best feature in the whole arrangement is the idea of independent control of street lighting.

Mr. Butterworth:—Mr. President, recently the *Journal of Gas Lighting*, London, Eng., made the statement that at some place in England—I cannot now remember where—a system of street lighting was in successful operation, where the lighting and extinguishing of the gas street lamps was done by means of raising and lowering the pressure. It is a system that has been tried and thus far has been successful.

MR. SCHWARM:—Mr. President, I would like to make a motion that a vote of thanks be extended to Mr. Knight for his valuable paper and the information contained therein, and that he be requested to present another paper, on the same subject, next year, after the experiments he is now conducting at Kalamazoo, Mich., have been completed. I think that such a paper would be of great value to us next year.

The above motion was then duly seconded and carried.

PRESIDENT McILHENNY:—We have time for another paper at this session. Unfortunately, H. L. Rice could not attend the meeting. I will ask Mr. Schwarm to read to us Mr. Rice's paper on

ECONOMY IN OXIDE PURIFICATION.

HENRY L. RICE.

Given good, well made oxide, the questions that enter into purifying economy are mainly those concerning box area, construction and arrangement, and the method of handling the material. What relative area and depth in our boxes shall we insist on, how many boxes in series, shall we use air or not and how much and where, shall we regenerate by drawing down (or blowing up) through the box, and (more recently) shall we reverse? These are a few of the very practical questions that are being asked and which call for an answer, whenever a change in purifying arrangements is projected. It is the writer's desire in this article merely to call attention to some results in purification achieved under rather unusual conditions at Norfolk, Va., works, and to suggest a possible bearing they may have on the answers to the above questions.

The new purifying house at Norfolk was placed in commission for water-gas January 1, 1902. The coal-gas was continued through the old house. The new water-gas boxes are two in number, 16 by 20 and 7 feet deep, flow divided up and down through two 3-foot layers of Connelly iron sponge and valved so that either box may be used first or alone. Provision is made for addition of a third box. The water-gas is well condensed before reaching the house, and passes through an 8-foot two-story shaving scrubber before entering the boxes. No trace of oil has been found in the scrubbed gas. Conditions permit an excellent degree of regularity in the pumping of the water-gas throughout each 24 hours. The maximum hourly pumpage has not exceeded 20,000 cubic feet, the past two years, while 15,000 is a nearer winter average, falling below 10,000 in summer. The house has therefore been used at one-half to one-third capacity, as it is rated equal to 800,000 feet per day, not estimating the divided flow quite as efficient as the double area one way. The top outlet of each box is equipped with a wooden slide to regulate the division of the gas, and the effect is watched by top and bottom test cocks. The boxes have been *reversed* regularly in action *once a week,* the second or clean box being put first. A change of oxide has been considered necessary only when the second box would not clean up, the first box fouling and the second remaining so. No revivifying air was used the first year, but this was injected the second year at the exhauster, except for part of the summer, in amount not averaging over one-half of one per cent. Three batches of oxide of 1,500 bushels each have been used in rotation and the oxide was absolutely new at the start. The results in these boxes for the past two years are as follows:

All new material—first filling—boxes ran from January 1, 1902, to March 1, passing 13,985,000 feet. Box A changed—boxes ran from March 1 to May 21, passing 16,176,000 feet.

Once used material in B. Condition of A governed—Box B changed—May 21 to September 23, passing 22,717,000 feet.

Material once used—Box A changed—September 23 to December 9, passing 21,354,000 feet. Box B changed—December 9 to November 23, 1903, passing 87,752,000 feet.

No change since November 23 and at this date, February 1, 1904, boxes doing well. Air was used after January 1, 1903. It was seen by the action of the boxes then that results would not further improve without it.

When the boxes were started the first box showed foul in one week. The alternative of reversal would have been emptying or regenerating. Reversal without air ran the boxes as above.

It will be noted that there was only one change in this house in 1903. The total labor for the year was $25 or 0.3 of a mill (0.03) cents per 1,000. There is no special method of handling the oxide. It is dumped out of the boxes and hauled up and thrown in by hand.

The coal-gas purifying house consists of four shallow boxes, 14 feet square, with old style center seal. These boxes allow a

2-foot layer of oxide—Connelly Sponge. Beginning January, 1903, the system of weekly shift was introduced into this house also. After considering possible alterations in piping, the simple plan was evolved of pushing the center seal one box ahead every week, all the boxes being kept full and covers down. During the year 52,000,000 cubic feet of coal-gas went through these boxes, the maximum being 240,000 feet per day. The result is uncertain in that there were 15 changes during the year for pressure and repairs to covers and trays. Pressure changes were frequently due to worn out trays and poor scrubbing, correction of which was not effected until late in the year. Yet there is the remarkable fact to record that not once in the entire year did the second box in the series show foul. No air has been introduced into the coal-gas.

These experiments were undertaken in an endeavor to ascertain under favorable conditions or area, if any revivifying efficacy resided in the purified gas. To Byron E. Chollar, who has patented a reversible purifying box, or series of boxes in which the flow of gas can be reversed in the box, and who covers in his patent the reversal of the flow in the box, must be given the credit for the first scientific employment of the theory that the revivifying process does not go on efficiently in the presence of hydrogen sulphide. It has shown to us conclusively in our experiment, and repeatedly towards the end of the last change, that the oxygen was carried mainly over to the second box, doing the work there that it refused to do in the first. In the ordinary method of box handling it must be that the revivifying air is driven farther and farther from the point of first contact, always operating where least needed, and finally in part escaping with the purified air; while with the Chollar boxes, or any method that places the fouled box or layer beyond the reach of the sulphur impurity, the introduced oxygen is effectually and wholly employed. Conclusions based on these observations will be advanced later.

The claim is now made (the writer does not know how seriously) by the exploiters of the novel form of box above mentioned that "the purified gas revives the foul oxide," and this is the point immediately under investigation. Our reversal system, already explained, allowed revivification to proceed under the favorable condition required for best results, in that the hydrogen sulphide was removed in the first (pure) box. The results during the first year seemed fairly conclusive that there was some revivifying virtue in the purified gas. The boxes did come back to condition and lasted many times as long as they would have without reversal. On the other hand, there was a limit to this agency and the use of oxygen added greatly to the efficiency. This in turn was only one-third the usual amount and slightly less than the theoretical amount for water-gas, yet by the method used the oxide purified over 50,000 cubic feet per bushel while practically new. It is the writer's belief that an efficiency of 100,000 cubic feet per bushel can be reached by careful application of observed results.

If the purified gas revives the foul oxide even in part then,

1. Oxygen must be present in the unpurified gas, or,—
2. Oxygen must be evolved in the process of purification.

The writer is not prepared to discuss either of these propositions except to suggest that even a casual inspection of analyses of various illuminating and fuel gases shows oxygen generally present in small amounts and that the admission of 1.5 per cent. of air which has been considered about right for revivifying in the old way (and why the same rough amount of water-gas as for coal-gas?) means only 0.3 per cent. of oxygen; and to ask the question, why, if the reviving method is efficient, should there be any oxygen present in the purified gas?

It is regretted that analyses of the gas at Norfolk, purified and unpurified, cannot be given, but facilities have not been available.

We thus have an experiment in the purifying of water-gas extending over two years, but which, while apparently successful so far, has from that very success afforded as yet only limited data. The coal-gas experiment is merely related as interesting as no deduction can yet be made from it. In case of the water-gas we may compile the facts as follows:

(1) Large area and moderate depth.

(2) Without air some revivification, failing however within low limits.

(3) With 0.5 per cent. of air revivification proceeded to high limits, giving,

(4) 52,500 cubic feet purified per bushel per change.

(5) 123,000 cubic feet purified per square foot area per change.

(6) This result, with material practically new, having been only once revived in the open.

(7) Cost of purifying labor 1903, 0.03 cents per 1,000, with no labor-saving machinery.

(8) Oxide in last change hard and dry. No pressure but picks necessary to remove it.

(9) The revivification took place on the second box, acting feebly or not at all in the first, where the oxide was fouling from the hydrogen sulphide.

(10) Slight trace of sulphur in the gas each reversal, sometimes showing in the mixed street gas for a short time, but only for a short time and never appreciable.

We hazard the following conclusions:

(1) Revivification *in situ* should for efficiency be conducted in the presence of the purified gas only.

(2) Unless positively proved objection as to the candle-power advantages lost, the logical point of introduction of the oxygen is after the first box in such quantity as will revive that box by the time the active box shall have fouled.

(3) The amount of oxygen required is not more than the theoretical amount and may be somewhat less, and is therefore less than has heretofore been thought necessary.

(4) Objection (if made) on the score of decreased candle-power from the use of revivifying air is thus minimized.

(5) Three boxes would be better than two, especially under more variable conditions, and when emptying and filling. No advantage beyond three.

(6) The material can be used without "regeneration" to a point where regeneration would not be effective.

(7) Great depth is not important, but area is. If area is sufficient (say in accordance with the one-fifth inch travel per second rule) fouling of the oxide proceeds slowly from the bottom to the top. Meanwhile the previously fouled box is being equally revived, and with sufficient reversals, only moderate depth is essential. Increase in depth is but the same in effect as increase in the number of boxes in series, and neither is economical.

(8) Investment of capital in elevating machinery of doubtful advantage and in regenerative air blowing equipment, not of any.

(9) Further experiments along these lines should be made with both coal and water-gas, following by analyses the course and action of the oxygen (both that in the gas and that artificially

added) under different conditions. Also a study as to the rapidity with which the fouled box can be revived by temporarily increasing the percentage of oxygen in emergency.

The writer is aware of the brevity of his facts and the wide range of his conclusions. The experiment at Norfolk is but begun and it is at the request of your President that the statement of its progress thus far and some attempt to form a working theory is made, in the hope that investigation may be stimulated elsewhere.

DISCUSSION.

MR. H. B. HARROP, Milwaukee, Wis.:—I have done a great deal of work on oxide purification with reference to fixed surphur compounds, and I expect within the course of the next year or so to do a great deal of work on hydrogen sulphide in our new gas works on the West Side. Some of the suggestions made in this paper will undoubtedly be of great value. There are a great many points made by Mr. Rice in his contribution that are extremely valuable, but there are some statements made by him which seem to me to be not quite in accord with the results that I have seen attained. Yet I feel that I have not pushed my experimental work far enough to make any further statements on the subject at this time. In reference to the Chollar system I may say that it is a very interesting and important feature of this work. The idea which that system is based on, that oxygen in the unpurified gas, that is, the oxygen in the presence of hydrogen sulphide does not revivify the oxide, is perhaps, the most important point in oxide purification, and whether that is so or not so will govern largely the results that may be had from handling oxide by this means.

PRESIDENT McILHENNY:—We will expect to have Mr. Harrop to write us a paper then about a year from now on this subject.

MR. E. M. OSBOURNE, Valparaiso, Ind.:—It seems strange to me that some of the larger works do not give us a little information on this subject. It also seems strange that any one writing to the Secretary of an Association of this kind, or to other people interested in such an important subject, is not able to draw forth information or suggestions which would be of much assistance to members who are connected with the smaller gas-works, because in the laboratories of the larger works they have opportunities of research and must have data which will be very valuable to those interested in the subject. But for some reason, I have been unable to have any reason assigned which seems satisfactory at least to me, they fail to give us the information. I would like to ask the Secretary, who, I feel certain, has endeavored to draw these people out, what success, if any, he has had in securing data on this subject. I know that a request was sent out by Mr. Doherty, asking for the names of people who would say something on topics of interest, and I remember having written to two or three persons personally, requesting them to give us data which would be valuable, and which they could give if they would, but which they refuse or at least neglect to furnish. I am at present not able to furnish any data. But if I had kept the data that at one time was in my possession, it probably would be very well received by those desiring information. I think, however, I will be able to give something on this subject in a year or two which may be of some value. I was unable to secure the data I desired at the time I was looking for it. I wish something could be done to stir up some of the good people and arouse additional interest on this subject. In the smaller works it seems to me that the question of purification is of rather minor importance. Take a works that has an output of 12,000,000 or 15,000,000 cubic feet annually, with a common ordinary purifying box and with Connelly sponge, the cost of purification does not amount to $100 per year, even less than that in my experience. In the smaller works there are other things it seems to me that are of more importance, but undoubtedly in the larger works it is a very important subject. The new purifying arrangement that has been spoken of in this paper, it seems to me, ought to stir up a renewed interest and result in important developments along this line.

MR. GREENOUGH :—As a representative of one of the larger works, I should be very sorry to have the impression prevail in this community that there are any figures regarding oxide purification which are not entirely at the service of Mr. Osbourne or any other member of this Association. I do not think that experiments on purification are going on to any great extent in most of the large works. I agree with Mr. Osbourne that the cost of purification in the smaller gas-works is so small as not to justify the expenditure of much time or money in experimentation. In the larger works, however, it of course, is a much more important feature of the business. Speaking with reference to the works with which I am connected, we have invested considerable money in experimenting in the regeneration of material *in situ,* and this has decreased the cost of purification in our works. There is very little to be said in regard to purification. The cost of it is so small per cubic foot of gas that we are now making hardly any experiments at all. Occasionally we make a test to ascertain how much sulphur there is in it. I object emphatically as a representative of one of the larger works in Ohio to the suggestion that we have any figures on the subject of purification which we are keeping back. We have no such figures. We have figures on other subjects which may be of interest to the gentleman, but certainly not on purification.

MR. BUTTERWORTH:—I agree with Mr. Greenough, and I presume we all do, that the operating cost in the matter of purification is a very small item of expense. It is not a matter of cost that makes it important, but the important matter is to have your gas free from hydrogen sulphide. I recently obtained data from a number of large and some small companies in relation to the operating cost of purification as compared with the investment cost, and I found as a result of that inquiry that if we could dispense with the purifying houses themselves, which some of the companies are doing, and put our boxes out doors we would save in interest on first cost, taxes, insurance and depreciation of buildings a sum equal to two-thirds the operating cost of purification. So that the best way for us to economize in the matter of purification, that I know of, is to dispense with the purifying house itself.

PRESIDENT MCILHENNY:—That is a good suggestion; very interesting and very important. We know that that has been done successfully. We had a paper at our last meeting which gave us a good idea of the mode of construction of such an equipment. It is a curious fact, however, that while we realized the truth of all that has been said about purification, nevertheless there are probably as many, if not more, questions or inquiries about purification in its different branches than most any other subject connected with the manufacture of gas, and we are apt to think that the small gas company has little trouble. But they appear to have more trouble with purification and to want more knowledge about it than the larger companies.

MR. SCHWARM:—Mr. President, I think it is a subject that interests the public more than the gas fraternity. Gas that is not absolutely pure will cause more kicks and complaints than all the low candle-power gas that we could furnish. It is a question that has a very wide scope. Your statement in regard to the number of questions that are asked by the smaller companies is undoubtedly true, as will be illustrated by going over Mr. Doherty's question list. To the larger companies, as Mr. Greenough and Mr. Butterworth have said, it is largely a matter of capital investment, but to the smaller companies it is an important question, not so much from the actual cost involved as it is the question of furnishing gas that is absolutely pure, and I think the object of the writer of the paper was more on these lines to show that in the ordinary sized gas-works an effort should be made to get the cost of purification down to the lowest limit, and also to furnish gas that was practically free and clean and pure.

MR. HAYWARD:—Mr. President, I labor under a little embarrassment always in discussing a subject of this kind; first, for fear that there may be an impression created that I have an axe to grind in the way of advertising. As you are all aware, I am an embassador of commerce. I am engaged not in selling kindling wood, but in selling iron sponge. The other embarrassment under which I labor in attempting to discuss this subject at this time is that I have not read this paper and I knew nothing whatever about it until it was read here a few moments ago. There is a good deal of interest in the matter of purification, more than perhaps we realize, because the men who want the most information are the men who are not here. The men who attend these Associations are the men who are pretty well posted. But it is the poor fellows who stay at home that want the information and they do not come here to get it. There is another feature in regard to this, and that is, while I am making oxide and selling it, I am not in the practical business of using it. Consequently whatever suggestions I may offer come from me second-handed. It is just what I pick up in going around and talking with you gas men and learning from you the bumps that you encounter. Therefore, as I say, my information is second-handed. Mr. Rice has thrown out two or three suggestions that I want to impress upon you in regard to the handling of the oxide. One of them is with reference to the condensers and scrubbers. You cannot secure efficient purification by using your purifying boxes as condensers or scrubbers. You must have efficiency before you reach your boxes. They must be larger and must have enough capacity. The suggestion that he makes in his paper of using the shavings scrubber before the box is a very valuable one, and I commend it to your judgment and to your use, because it does take up the oily vapors that are carried forward. If you allow them to accumulate in the purifying boxes you spoil your oxide, not because it has absorbed the sulphur, but because it has become oily and in that condition it is never in any condition to reoxidize or revivify as most of you know. During the past year I have been advocating the introduction of oxygen by means of a little blower which is attached to the exhauster. It is a very simple device; it costs but very little money and it saves considerable in the way of labor. Now, when you can get the cost of labor for purification down to about one-third of a mill, that is pretty cheap. As Mr. Rice says in his works in Norfolk, he was able to secure that result. But aside from the cost. there is a lot of nuisance in changing your boxes and looking after them, and if you can save that annoyance and trouble that is worth a good deal. Mr. Rice changed his boxes but once during the year 1903. That is down to a pretty fine point, it seems to me, and it is well worth your consideration.

MR. STONE:—I think Mr. Greenough has stated the exact fact in what he has said as to the difference in the request for information as between the manager of a small gas-works and the manager of a large one. In the case of a small works, oftentimes the works are constructed entirely too small in the first place. The consumption has increased and the works have been enlarged, and he finds that his scrubbing capacity is not what it ought to be, and his condenser capacity is not what it ought to be, and possibly his purifying capacity is not what it ought to be, and he wonders why it is. He wonders why it is that he has to change his boxes about once a week and the manager of some other company has to change his boxes only once in six months or once a year, as stated by Mr. Rice. In running a small gas-works, and especially a coal-gas plant, the stokers do not like to do this work, and the manager does not like to keep a man around the works especially to do that kind of work. It is dirty and disagreeable, and they may have a little trouble in getting men to do it and to do it regularly. Not only that, but the matter of looking after it is somewhat of a burden. If you have to change your boxes very often and have to look after them very often it is a matter of considerable annoyance if you have to watch them closely. It is one of the points connected with a gas-works where you have to watch the work all the time and it is these things that bother you which you are called upon to watch continually. That is the reason that the manager of a small works experiences more trouble on this subject than the manager of a large works. It has occurred to me that Mr. Greenough struck the point exactly when he brought these facts out. If the manager of the smaller works had the same facilities as the manager of the larger works, he would not be bothered so much. If his boxes were large enough and the scrubbers were large enough and the condensers large enough and he had the right kind of oxide he would not need to change any oftener than the manager of the larger works.

Mr. Harrop:—Mr. President, I might volunteer one statement in addition to what I said a few moments ago. This paper makes a point as to the action of oxygen on the foul oxide, in the presence of hydrogen sulphide, and out of the presence of hydrogen sulphide. I said that I was not able to state this definitely, but there is one thing I can say. I had a paper at the last year's Detroit meeting of the McMillin Managers' Association, covering a rather exhaustive set of experiments which I made on the oxide purification in our Third Ward works, with its bearing on carbon bi-sulphide, and I have shown conclusively that some carbon bi-sulphide is stopped in the boxes in a very small measure, even when the material is absolutely new. Now, the hypothesis we work on is the physical absorption of the carbon bi-sulphide by free sulphur, and the indications are that the iron is sulphided by the hydrogen sulphide the oxygen in the gas oxidizes the iron sulphide and frees the sulphur, and this free sulphur absorbs a small quantity of the carbon bi-sulphide. Supposing we have three boxes in a line, and if the gas is thoroughly purified in No. 1 and No. 2, and supposing there is free sulphur in No. 3 box, then it is easy to see how carbon bi-sulphide is absorbed by the sulphur in No. 3 box, without interfering with the contention made in the paper under discussion. But if the first box is now material, and it is found that less carbon bi-sulphide is in the gas at the outlet of that box than at the inlet of the box, and there has been absorption of carbon bi-sulphide in that box of new material, it would seem to indicate that the iron sulphide formed in that box from the hydrogen sulphide has been revivified, presumably by the oxygen in the gas, and also presumably in the presence of the hydrogen sulphide. I state that as a fact. The quantity absorbed is exceedingly minute, but it is absorbed, and there seems to be no way of getting around the fact, or the apparent fact that the iron sulphide is oxidized in the presence of the hydrogen sulphide. In reference to what His Excellency, the Ambassador, said of the importance of scrubbing and condensing the gas before it reaches the purifiers, Fred Bredel told me this morning that he was working on 7 per cent. sulphur-coal out in Kansas, and had 14 scrubbers and washers, with a small purifying system which was not worked to its full capacity. It would look as though that washing was pretty thorough. If Mr. Bredel is in the room I would like to hear from him on that subject.

PRESIDENT McILHENNY:—Mr. Bredel, your name has just been mentioned in connection with the purification of gas from 7 per cent. sulphur-coal, with 14 scrubbers and washers and a small purifiing equipment. We are discussing the question of "Economy in Oxide Purification," and we would be very glad to hear from you on it.

MR. FRED. BREDEL, Milwaukee, Wis.:—It is a question of purifying Kansas coal. I want to say I had an experience once with Illinois coal, for it was claimed that it could not be purified by the oxide of iron. The only question is, how often you want to wash your gas. If you do not mind 20 inches or so of back pressure, you can do it. The absorption of carbon bi-sulphide is to a small per cent. a chemical action, but I think that the real action is a mechanical action. Bi-sulphide of carbon being condensed out of the gas, the point of liquefaction of the bi-sulphide of carbon is higher than the ordinary temperature under which the gas is sent through the apparatus. Now, if you wash long enough, the bi-sulphide of carbon is removed. If you wash with fresh water the illuminants are also dropped. If you wash with saturated ammoniacal liquor, there is no danger of absorbing the illuminants, but the sulphur will be removed, but not if you use only one or two or three washes. The washing has to be done at a temperature above 80. Some of the coal we have used down there has analyzed 11.6 per cent. sulphur, and the average is between 6 and 7 per cent.

MR. STONE:—Before we leave the subject, there is one point I would like to get clear in my mind. Do I understand this system as advocated by Mr. Rice does not in any way conflict with the patent that has been granted Mr. Chollar for the purification of gas by means of a reversal of the flow? This system that is advocated by Mr. Rice is with reference to the purification of the gas by passing it in the same direction, as I understand it, and Mr.

Chollar's system is based on the purification of the gas by passing it in a reverse direction to that in which it has passed before. The question in my mind is whether or not there is any conflict between the two methods?

President McIlhenny:—I will say that I feel quite sure that Mr. Rice would not use or advocate the use of anything which he thought conflicted with any established right.

Mr. Schwarm:—I think the purification proposition is an interesting one to all, and one of the hardest to deal with from a manager's standpoint. I would like to hear from Mr. Lynn, who, I understand, uses Kansas coal at Joplin, how they purify their gas. I understand it has quite a good deal of sulphur.

Mr. James T. Lynn, Detroit, Mich.:—We are purifying entirely with lime. We cannot use oxide with the Kansas coal. Mr. Young, who is here, has had practical experience on this subject. I have had no practical experience at Joplin. We tried oxide, but had to abandon it. We did not, of course, have 14 washers or scrubbers, or anything of that kind, but we had the ordinary condensing apparatus, and had a hot scrubber besides, but we could not purify at all with oxide. We had to use lime.

Mr. Bredel:—I may say we used iron purification, and not lime.

President McIlhenny:—If there are no further comments or inquiries the discussion on this topic will come to an end.

It was then moved, seconded and carried that Mr. Rice be extended a vote of thanks by the Association for his very valuable, interesting and instructive paper on the subject of "Economy in Oxide Purification."

President McIlhenny:—We will not take up any further topic at this session. I would urge upon the members, however, that they be as prompt as possible in convening at 2 o'clock, as we have a very large and instructive program before us this afternoon.

On motion, duly seconded and carried, the Association then took a recess until 2 o'clock P. M. of same day.

FIRST DAY—AFTERNOON SESSION.

The Association met at 2 P. M. As Mr. Eysenbach was unable to be present, Mr. Chas. S. Ritter, Detroit, Mich., was called upon to read the Wrinkle Department for him.

WRINKLE DEPARTMENT.

E. E. EYSENBACH, EDITOR.

NO. I. AIR INJECTOR.

Mr. S. O. Fulkerson, Superintendent of the St. Charles Light and Fuel Company, Mo., gives the following method for introduc-

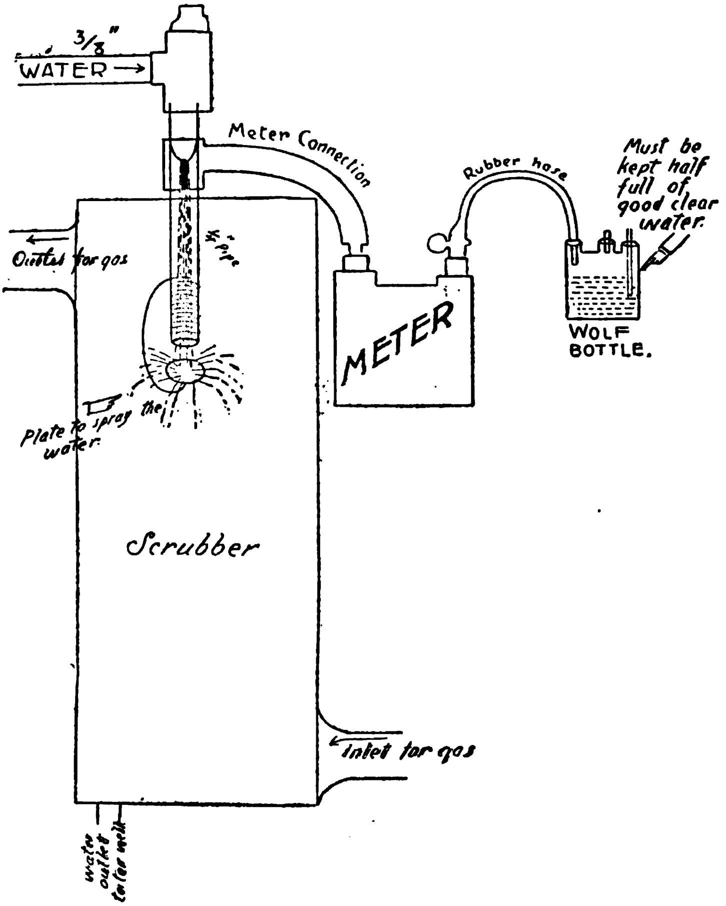


FIG. I. INJECTOR ADDING AIR TO GAS FOR PURIFYING PURPOSES.

ing air for purification purposes. As there is no exhauster he injects 2 per cent. of air by means of a water syphon in the top of the scrubber. Fig. I explains the method. It is an old principle used in a new way. The water is taken direct from city main and costs about $2.50 per month. The meter measures the air and the Wolf Bottle furnishes moisture for the diaphragms. The little plate under the injector forms a spray for the removal of the ammonia in the gas, the water serving the double purpose of injecting the air and scrubbing the gas.

NO. II. STAIRWAY WHERE SPACE IS LIMITED.

V. F. Dewey, Assistant Superintendent at Detroit, sends a description of a stairway in use at Station "B" of the City Gas Company. This stairway (Fig. II) was designed by the Western Gas Construction Company, and can be used in many places to

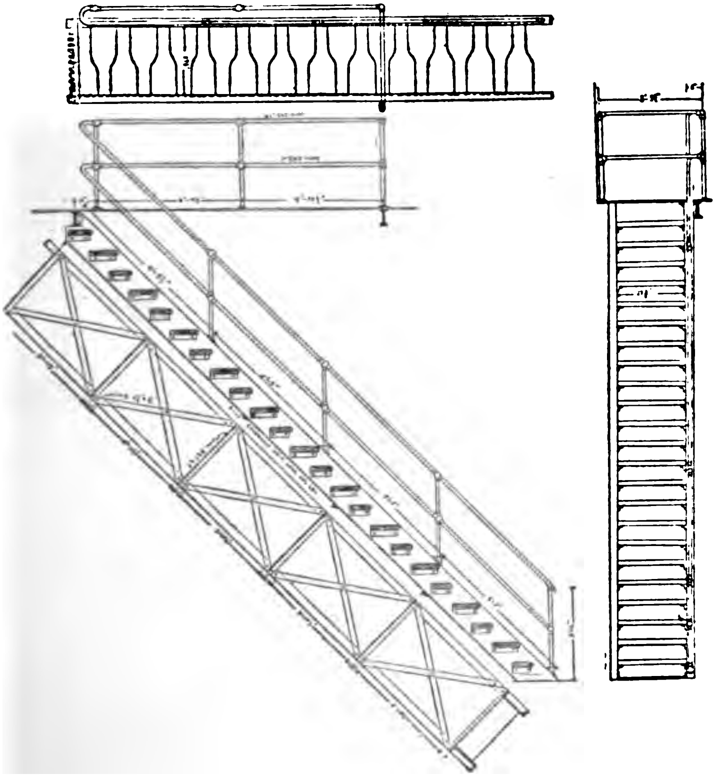


FIG. II. PLANS FOR STEEPLY INCLINED STEPS.

great advantage, as it can be built at a greater angle economizing space. Alternate spaces are cut out on opposite ends, as shown in the drawing. You must start with the correct foot and keep in the middle of the stairway.

NO. III. CONTROL OF GAS EXHAUSTER BY MEANS OF STEAM-REDUCING VALVE.

H. L. Rice, General Manager of the City Gas Company of Norfolk, uses a reducing valve on the steam line leading to his exhausters. This insures a constant pressure on the steam line and proves valuable when boiler pressure varies, as it often will, when making water-gas. The gas governor has only the variation in gas made to compensate when steam pressure is constant.

NO. IV. ADVERTISING APPLIANCE SALES.

The Detroit Company has a special sale of some certain gas appliances each month, advertising same on envelopes used in mailing out bills, a scheme inaugurated by Mr. Ewing and Mr. Ritter.

NO. V. EXTENSION BIT.

C. E. Hutchinson, of the Berlin, Wis., Gas Company, contributes a description of an extension attachment to an augur. It consists, as shown in Fig. III, of about 5 inches of ½-inch pipe, threaded on one end and slipped over the shank of the bit. It is then soldered to the shank and poured full of lead. The handle is made of ½-inch pipe. Extensions are easily made with pipe and couplings.

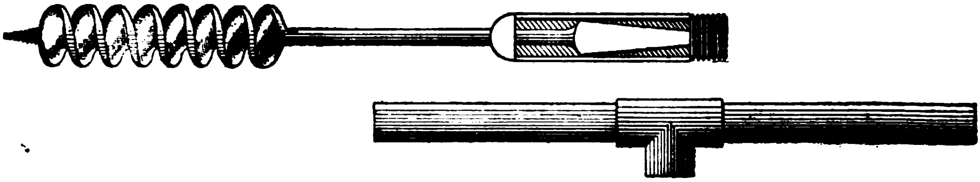


FIG. III. EXTENSION BIT.

NO. VI. METER CAP.

J. Chas. Andrews, of the Denver Gas and Electric Company, describes a tin meter cap, shown in Fig. IV. It is used on meters out of service to exclude dirt and air, and can, of course, be used over and over again. They seem to be better than corks, as corks are apt to get pushed down in the pipe and the meter set without noticing it. The tin cap also protects the thread. It is made in a die, threads being stamped, in sizes from 3 light to 20 light.

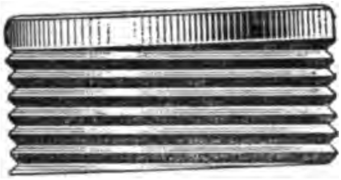


FIG. IV. TIN PIPE JOINT CAP FOR METER NOT IN SERVICE.

NO. VII. WASH BOX OVERFLOW.

John T. Mason, Superintendent of the Milwaukee Gas Works, uses wash box shown in Fig. V on his Lowe water-gas sets. It has a 2-inch syphon overflow with its point of overflow 3 or 4 inches higher than the main overflow. This arrangement has

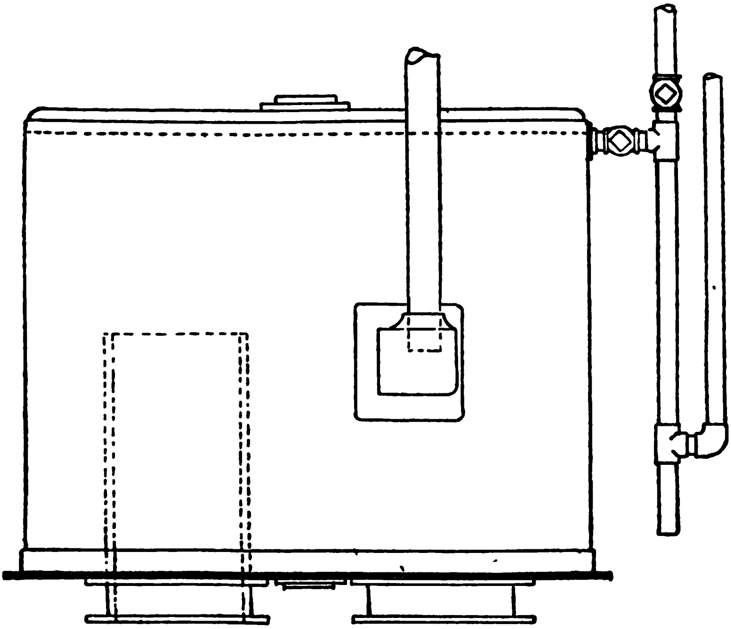
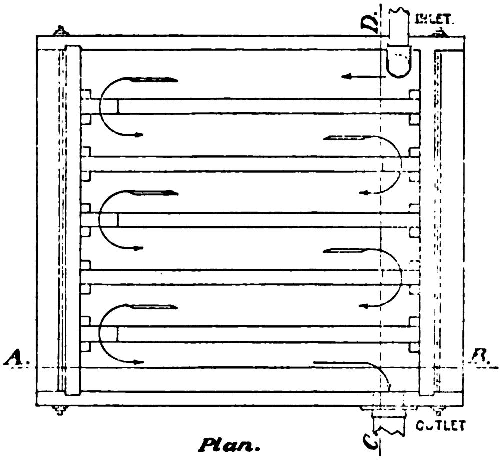


FIG. V. WASH BOX OVERFLOW FOR LOWE SETTING.

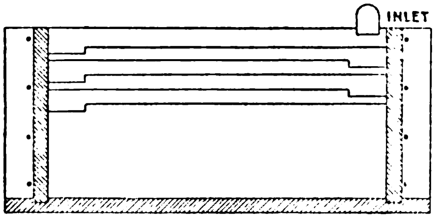
helped to prevent carbon deposit in the take-off by reducing the back pressure. When increased pressure comes on the wash box it forces the tar from the bottom.

NO. VIII. SETTLING TANK.

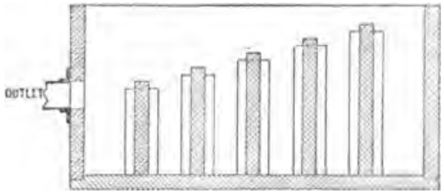
Mr. Mason also sent me Fig. VI, a settling tank used between the waste overflow from the ammonia plant and the main sewer. This settles out the lime and dirt, which is removed once a week.



Plan.



Section A.-B.



Section C.-D.

FIG. VI. SETTLING TANK FOR WASTE OVERFLOW FROM AMMONIA PLANT.

MACHINE AND TOOLS FOR METER CONNECTIONS.

MACHINE AND TOOLS FOR METER CONNECTIONS.

NO. IX. RECOVERY OF HEAT FROM GAS ENGINE EXHAUST.

C. H. Williams, of the Madison Gas and Electric Company, uses a feed water heater on the exhaust manifold of a gas-engine by means of which he is enabled to raise the temperature of the jacket water of the gas-engine to boiling point. The water is then used in gas-works boilers, saving 12 per cent. of fuel cost.

NO. X. MACHINE AND TOOLS FOR METER CONNECTIONS.

This relates to the machine and tools used at Detroit for making meter connections. An emery wheel grinds off the end of the couplings much more smoothly than the file, and in one-half the time. The tools, illustrated in Fig. VII, do the work of the rasp and the scrape hook after lead is cut into proper length. They are fixed into an upright power drill press and the lead brought in contact by an upward hand pressure; the outside is peeled clean and it is then ready to be soldered into the fitting. Eight times as much work can be turned out by this method as by the old.

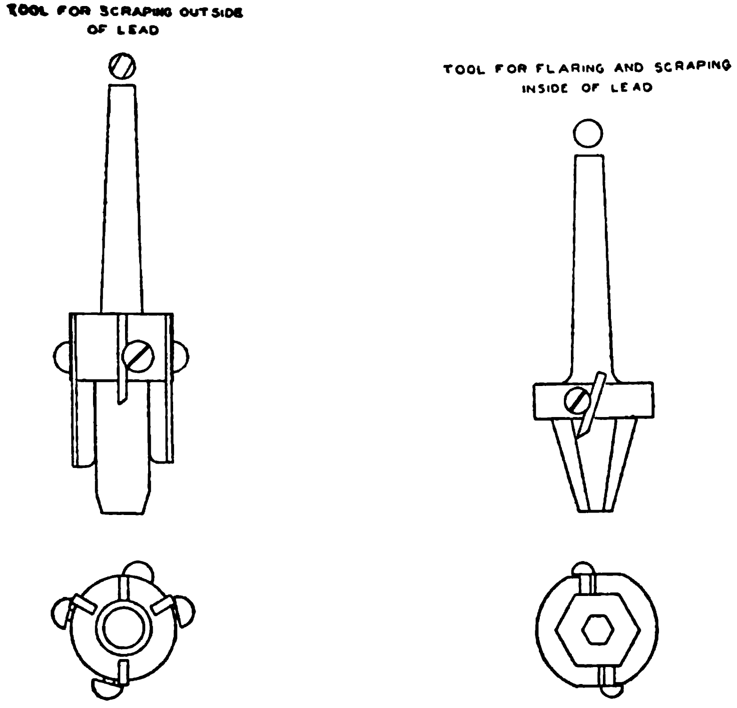

TOOL FOR SCRAPING OUTSIDE OF LEAD
TOOL FOR FLARING AND SCRAPING INSIDE OF LEAD

FIG. VII. TOOLS USED AT DETROIT IN MAKING METER CONNECTIONS.

NO. XI. A RETORT DE-CARBONIZER.

Fig. VIII explains itself. It was contributed by M. E. Malone, of the Denver Gas and Electric Company. There are many methods for de-carbonizing retorts. Perhaps this is the best one. It was designed by Henry L. Doherty and has been in use at Denver for some time. We have been able to remove quite a heavy deposit of carbon from a retort in 55 minutes. The ½-inch pipe is inserted in the 2-inch and extends to within 1½ inches of the end, and is kept in place by three "spiders" placed at equal distance apart, which allows an annular space between the two pipes for the compressed air which escapes through the numerous ⅛-inch holes (placed 4 inches apart) in the sides of the 2-inch pipe and ¼-inch holes in cap on the end of 2-inch pipe. Steam is admitted through ½-inch pipe and escapes through ⅛-inch holes (also 4 inches apart) into the 2-inch pipe, keeping the apparatus cool and prolonging its life. Both air and steam inlets are connected with steam hose allowing the turning on of the steam before placing it into retort. The holes in the ½-inch pipe are vertical and midway between those in the 2-inch pipe. In the 2-inch pipes they are slightly below the horizontal. Air pressure is 18 degrees. Steam pressure, 60 degrees.

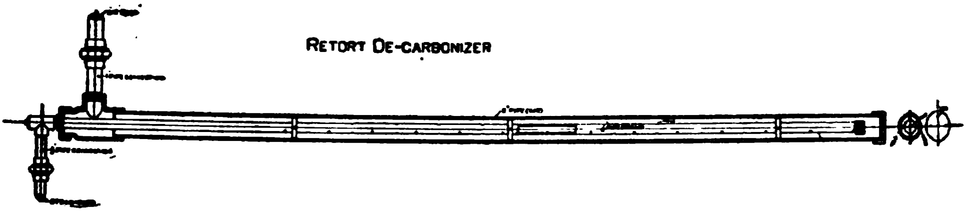


FIG. VIII. A STEAM-AIR RETORT DECARBONIZER USED AT DENVER.

NO. XII. REGULATING GAS PRESSURE IN DISTRIBUTING MAINS.

Last, but not least, is a contribution from Mr. Baehr, of the Laclede Company at St. Louis. He writes that the idea of this wrinkle is to enable a man at a holder to regulate the pressure according to the amount of gas going out, that is, relative to the velocity. The details of this device were worked out by S. E. Reinhart, of the Laclede Company. Figs. IX and X illustrate the differential pressure gage and the Pitot tube, with extra nozzles.

With proper precautions this combination ought to make a good meter. Under high pressures the Pitot tube gives good results; with a sensitive pressure indicator, it might give good results under low pressure. In seeking a simple as well as a practical method for indicating at sight the gas consumption, so as to be able to regulate the distributing pressure at the station governor accordingly, it was decided to do so by means of a Pitot tube attached to the main and connected to a suitable gage indicating the respective velocity heads due to the flow of the gas through the pipe as the consumption varied. By trial, proper distributing pressures and corresponding velocity heads are ascertained and tabulated; or a scale graduation may be placed upon the gage which gives direct readings of proper pressures to be carried. Thus any unusual or sudden consumption will be shown upon the gage and the proper pressure to be carried indicated.

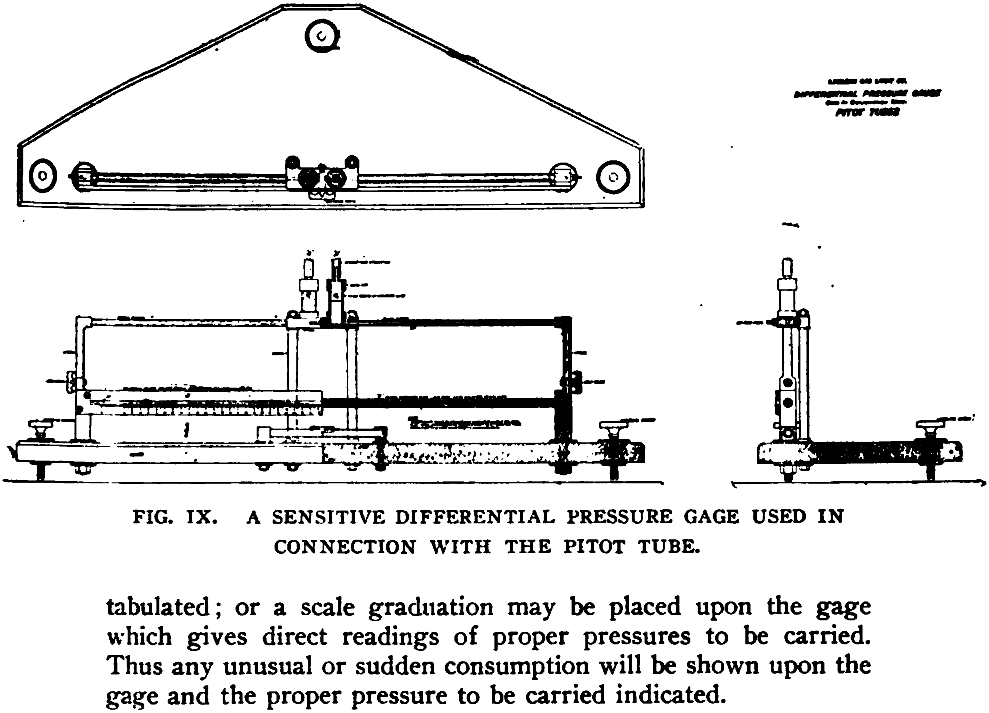


FIG. IX. A SENSITIVE DIFFERENTIAL PRESSURE GAGE USED IN CONNECTION WITH THE PITOT TUBE.

Special Apparatus.—A composite Pitot-Piezometer tube and a sensitive differential pressure gage of special design, as shown in detail of drawings entitled, "Pitot Tube" and "Differential Pressure Gage," respectively, were adopted. The sensitive differential pressure gage is designed on the displacement principle, the same as "Segur's Differential Gage," described on page 146 of

"The Calorific Power of Fuels," by Poole, and consists essentially of a capillary "T" of 1 millimeter bore, containing a mercury bubble "M," with water connections on either side of it to the pressure receiving chambers, "C_1" and "C_2" above. When in

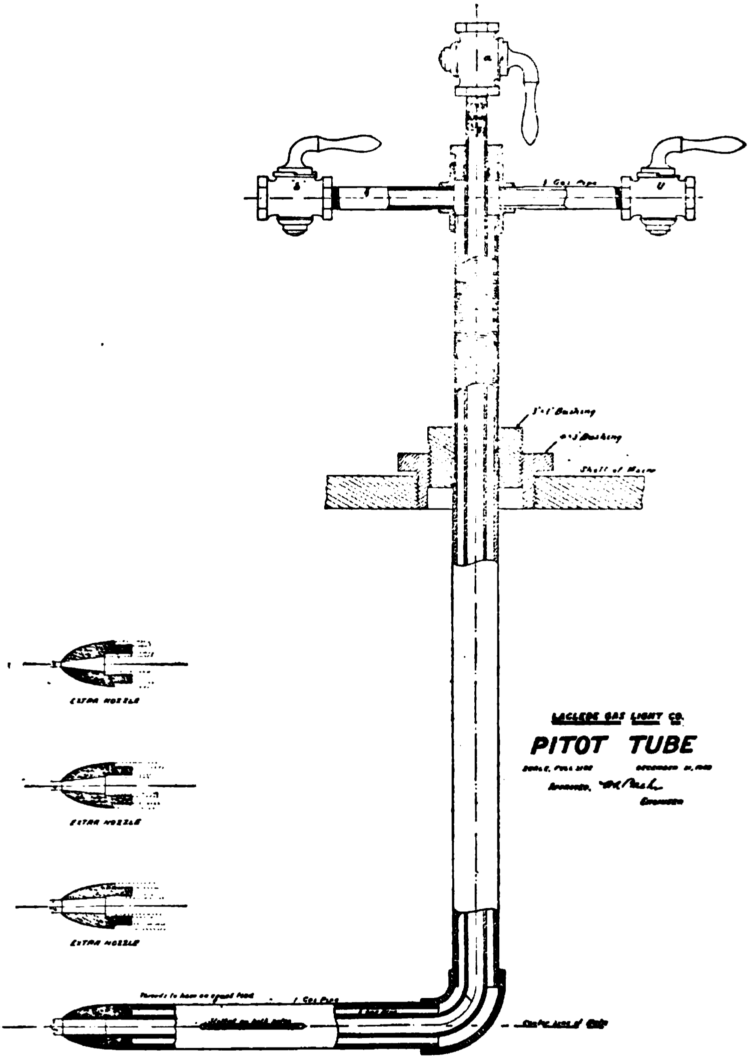


FIG. X. SECTION OF THE PITOT TUBE AS PLACED IN GAS MAIN.

proper adjustment (with stop cocks open and by-pass cock closed) and with like pressures acting upon the two water surfaces in the "C_1" and "C_2" chambers, these water surfaces will stand at the same level, while the mercury bubble will be at its initial position or zero on the scale "S."

However, should a greater pressure be transmitted to chamber "C_1" through the rubber hose connection "A," than to "C_2," through its connection "B," the water level in "C_1" is lowered, that in "C_2" is raised correspondingly and the mercury bubble "M" moves to the right a distance proportionate to the water displacement in the chambers "C" and "C."

The design in this case calls for a 2 millimeter movement of the mercury bubble "M" for a variation of 0.01 millimeter in the water levels in the chambers "C" and "C." The range or sensitiveness of this differential pressure gage may be modified by proportioning the dimensions of the capillary tube "T" and pressure receiving chambers "C_1" and "C_2" to suit the required conditions.

Method of Operation.—The Pitot tube is attached to the gas main so that the nozzle is turned against the direction of the flow of gas and so that its axis coincides with the axis of the pipe.

Pressure due to the impact plus the static head is transmitted from the nozzle through cock "a" and connection "A" to chamber "C_1." were static pressure through the slots behind the nozzle through cock "b" and connection "B" to chamber "C_2." Static pressure is also transmitted to a manometer through cock "U."

Thus it is evident that a pressure corresponding merely to the impact head alone acts to cause displacement of water levels in chambers "C_1" and "C_2" and the deflection of the mercury bubble "M" is proportionate to this displacement.

The reading on the scale corresponding to the deflection of the mercury bubble "M" indicates the static manometer pressure required. The governor is regulated accordingly.

DISCUSSION.

PRESIDENT McILHENNY:—The Wrinkle Department always brings out many useful suggestions which help in practical difficulties. Are there any comments to be made upon any of the wrinkles that have been presented to us?

MR. SCHWARM:—Mr. President, I would like to ask about the Wrinkle marked No. 11, on the subject of "Retort De-Carbonizer." That provides for a compressed air plant, does it not? As

I understand it the air pressure is 18 pounds, and the steam pressure 60 pounds. Does that require a Westinghouse compressor, or some sort of air compressor?

MR. M. E. MALONE, Denver:—It would require some kind of a compressor, of course. You could get good results, perhaps, at a less pressure, but I think you would get better results probably at that pressure than at any other.

MR. DOHERTY:—I would like to answer Mr. Schwarm's question by saying that a compressor would not be necessary there at all. You could use a fan if you wanted to. We have a compressor, so we use compressed air; but by simply enlarging your outer pipe slightly and using a small fan of some sort, or a blower, you could get the same results. We have another de-carbonizer in use in another plant with which I am connected. It was one I designed originally for Denver. We have simply a fan belted to a little fan motor and we use that. I did not know that this Wrinkle was in the Wrinkle Department. I had intended to put it in, but I guess Mr. Malone understood that, so he sent it in. I meant to explain it more fully. If you use air alone to de-carbonize retorts, the temperature increases in the retort to perhaps a dangerous point, and if you use steam alone it tends to cool your retort too much. You can so adjust the combination of air and steam to retain your retort at the same temperature and still work very rapidly. The de-carbonizer is not in perfect shape yet, but when we get it in perfect shape it will channel out the carbon over 10 inches, and a bar behind it will enable one to rake out the carbon.

MR. OSBOURNE:—I would like to ask what bad effects it would have on retorts, or whether it would in any way deteriorate them so they would have to be patched up, or any thing of that sort?

MR. MALONE:—We have had it in operation about four or five weeks only. We keep the retort de-carbonized right along, so that we have used it perhaps only a dozen times. As far as we have seen we have noticed no injurious effect at all.

MR. DOHERTY:—There are two questions on this subject in the Question Box, being questions numbered 38 and 89.

It was then moved, seconded and adopted that a vote of thanks be extended to Mr. Eysenbach for his work as editor of the Wrinkle Department.

PRESIDENT McILHENNY:—It is evident from this contribution that Mr. Eysenbach has spent a great deal of time and labor upon it and it is certainly a very valuable addition to our literature. We have the honor, at this meeting, to have a contribution from across the water. It is by Mr. J. T. Westcott, of England, and is on the subject, "Why English Gas Outputs are Large, with Lessons to be Drawn in the United States." I would say that Mr. Westcott formerly lived in the United States and was most highly regarded here for his general attainments, ability, etc. It is quite a favor to have a paper from him. He unfortunately could not be present to read it himself. I will ask Mr. Osbourne to read the paper for him.

E. M. Osbourne then read the following paper:

WHY ENGLISH GAS OUTPUTS ARE LARGE, WITH LESSONS TO BE DRAWN IN THE UNITED STATES.

J. T. WESTCOTT.

Your President, having suggested the subject of this paper, one of my assistants, Ralph Carr, Jr., prepared, from the Gas Directories of 1902, the following tables of representative towns, in different countries. They are converted to American standards and arranged in the order of greatest consumption. In places having a scale of rates, the net price, for illustrating purposes only, is given.

The per capita wealth of most countries is proportionate to the amount of gas consumed.

You who have visited London, during the winter, will recall to mind the overcast skies, through which the sun's rays failed to penetrate for weeks at a time. To vary the monotony of the cool, damp, dull atmosphere, you will remember the different days you experienced fog, and if you happened to be out in one of the black, commonly known as "pea soup" variety, it will doubtless remain vivid in your recollection the remainder of your life. These conditions are responsible, for a much greater number of lighting hours, during the year, than are required in the United States. Some days artificial light is resorted to during most of the day, and occasionally the entire day.

The temperature in England rarely registers over 90 degrees during the summer, nor many degrees below the freezing point in winter. Occasionally, for a few days there are cold spells, in which from 4 degrees to 10 degrees of frost will be registered

COMPARISON OF OUTPUT FROM BRITISH, AMERICAN AND GERMAN GAS PLANTS.

England.	Population of District.	Total No. of Consumers	No. Using Slot Meters.	Annual Make in Cubic Feet.	Candle-power.	Price per 1,000 cu. ft.		Yearly Consumption.	
						s. d.	Cents.	Per Capita.	Per Con-sumer.
London, South Metropolitan	1,475,728	214,000	113,540	11,274,916,000	14	2-3	54	7,640	52,686
Liverpool	790,000	86,550	23,001	3,735,470,000	20.5	2-11	70	4,728	43,159
Birmingham	725,000	81,000	16,200	3,044,099,000	16.5	2-3	54	8,336	74,618
Manchester	720,000	133,089	35,818	4,735,300,000	19	2-6	60	6,577	35,580
Leeds	428,953	97,309	14,169	3,140,870,000	18	2-3	54	7,322	32,277
Sheffield	410,000	63,438	......	2,874,692,000	17.33	1-8	40	7,011	45,315
Newcastle	365,000	41,179	168	2,893,603,000	16	1-11½	47	7,927	70,268
Brentford	*160,000	44,298	20,971	1,925,145,000	16.5	2-11	70	12,032	43,459
Sunderland	150,000	16,882	......	966,165,000	15.5	1-6	36	6,441	57,230
Darwen	38,211	8,850	1,791	203,731,000	18.25	2-5¼	59	5,332	23,020
Widnes	35,000	6,176	3,836	244,520,000	19.75	1-1	26	6,986	39,592
Average	481,627	72,070	25,499†	3,458,046,455	17.39		52	7,303	47,019
Scotland.									
Glasgow	950,000	20,564	328	6,121,367,000	20.75	2-6	60	6,443	29,634
Edinburgh	400,000	85,774	5,369	1,917,548,000	24.5	3-4	80	4,794	22,356
Dundee	160,871	40,704	3,974	611,452,000	20	3-10	92	3,800	15,022
Aberdeen	154,000	34,200	4,000	616,493,000	23	2-8	64	4,003	18,026
Paisley	80,000	19,559	925	380,848,000	26.33	2-6	60	4,760	19,471
Greenock	70,000	12,246	865	302,012,000	23.75	3-4	80	4,314	24,662
Perth	40,000	8,748	2,118	175,823,000	25	3-4	80	4,395	20,098
Average	264,981	58,256	2,483‡	1,446,506,143	23.33		73.71	4,644	21,324

United States of America.									
Chicago Peoples' Gas L. & C. Co....	2,000,000	323,089		7,425,979,693	26		1.00	3,713	22,984
Brooklyn Union Gas Co.	2,000,000	175,000		5,500,000,000	28		1.00	2,750	31,428
Philadelphia	1,500,000	190,407		5,885,000,000	23		1.00	3,923	30,907
Baltimore	550,000	57,889		1,847,436,000	20		1.00	3,359	31,913
Cincinnati	340,000	34,000		1,240,000,000	18		0.75	3,647	36,470
Cleveland	325,000	30,000		1,500,000,000	18		0.75	4,615	50,000
Pittsburg Consolidated Gas Co.....	320,000	19,293		636,691,000	22		1.00	1,989	33,001
New York Central Union	125,000	......		700,000,000	21		1.00	5,600	......
Northern Union	80,000	8,000		250,000,000	22		1.00	3,125	31,250
Average	804,444	104,710		2,776,122,966	22		0.96	3,636	33,494
Germany.									
Berlin	1,902,009	156,015	2,045	5,686,430,105	15.87		0.84	2,989	36,447
Dresden	410,000	33,563	.....	1,154,454,122	15.20		0.88	2,815	34,396
Cologne	378,146	26,434	.....	1,281,200,075	15.52		0.90	3,388	48,467
Leipzig	313,307	32,515	.....	887,509,690	14.73		0.98	2,832	27,295
Darmstadt	73,000	7,240	44	144,515,527	18.48		1.01	1,980	19,960
Freiburg	61,000	5,575	16	146,801,570	15.07		1.14	2,406	26,332
Hildersheim	47,500	3,820	.....	118,501,319	18.50		0.97	2,494	31,021
Average	459,995	37,800	352§	1,345,630,344	16.19		0.96	2,701	31,988

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*Population has probably increased since this census was taken.

†Consumers using slot meters amount to 32.21 per cent.; Sheffield and Sunderland are omitted as the number of slot meters is not given.

‡Consumers using slot meters amount to 4.26 per cent.

§Consumers using slot meters—0.93 per cent. including the average of the seven towns in the table. We understand four had no slot meters in use.

(in America we would say the thermometer stood at 28 and 22 degrees). This comparatively slight variation of temperature accounts for a different method of heating the buildings. Until recent years, this was accomplished by a grate fire in each room, using bituminous coal. Now most houses are provided with gas heating stoves fixed in the fire-place, varying in number according to the size of the house and the opinions of the occupant. The American central heating systems are generally unknown except a few recent installations by American representatives. The heating of a number of rooms in English houses by gas stoves accounts for a larger fuel consumption than our conditions permit.

The approximate amount can best be gauged by quoting from a letter of December 21, 1903, from Sydney Y. Shoubridge, the engineer of the Crystal Palace District Gas Company:

"In reply to your letter of the 19th inst., I enclose herewith statement showing the output of gas from our works each month during the year 1902.

"I cannot say exactly how much of our gas is used for fuel purposes, but the consumption during the daylight hours amounts to 45 per cent. of the whole. Of course, there would be a considerable consumption for fuel purposes after daylight hours. On the other hand, there would be some small consumption for lighting in dark places during daylight, but, after making allowance for these, I think it would be safe to say that from 50 to 60 per cent. of the gas we supply is used for purposes other than lighting."

And from a letter of December 22, 1903, from Samuel R. Ogden, engineer and manager of the County Borough of Blackburn Gas Undertakings:

"Replying to yours of the 19th inst., I append particulars of our monthly gas consumption for 12 months.

"I am sorry I cannot give you any reliable information regarding percentage used for fuel purposes, our price being uniform for all purposes; separate meters are not fixed.

"Probably percentage of gas used for fuel purposes here would be roughly 50 per cent. in summer, 20 per cent. in winter."

The monthly output of these two undertakings is given in the tables.

MONTHLY OUTPUT OF GAS PLANTS IN TWO ENGLISH DISTRICTS.

CRYSTAL PALACE DISTRICT GAS COMPANY. Residential portion of the London District—Monthly Output of Gas for 1902.				COUNTRY BOROUGH OF BLACKBURN (Municipal Ownership). Manufacturing district of the north—Monthly Output of Gas, 1902-1903.			
Summer.	Gas output.	Winter.	Gas output.	Summer.	Gas output.	Winter.	Gas output.
April	98,414,000	January	157,742,000	April	37,866,000	January	83,222,000
May	91,908,000	February	137,382,000	May	31,194,000	February	62,156,000
June	78,388,000	March	118,695,000	June	26,361,000	March	52,995,000
July	78,299,000	October	116,496,000	July	27,088,000	October	57,858,000
August	82,396,000	November	132,061,000	August	29,568,000	November	73,534,000
September	94,988,000	December	159,154,000	September	38,661,000	December	88,095,000

From the following figures of these two undertakings, you will notice the difference between the summer and winter consumption:

	Population of District.	Annual Make.	Consumption per capita.	SIX MONTHS' OUTPUT.		THREE MONTHS' OUTPUT.	
				Summer.	Winter.	Summer.	Winter.
Crystal Palace	(a).......	1,345,923,000	(b) 7,500	524,393,000	821,530,000	239,083,000	454,278,000
Blackburn	130,000	608,598,000	4,681	190,738,000	417,860,000	83,017,000	433,473,000

(a) This company's area of supply embraces part of five different local districts. For this reason we are unable to give the correct population of the district.

(b) Approximately correct.

Incandescent and high power gas lights are used for street illumination throughout the country in a much greater proportion than in America. There are also fewer electric lighting installations in use.

During the year 1901 about 14 per cent. of the Birmingham Corporation's gas consumption was for motive power. During the past year another British undertaking sold about 10 per cent. of their consumption for gas engine purposes. It will be noticed a large amount of gas is used in England for motive purposes.

Kerosene or lamp oil is retailed to the householder in America at about 12 cents per gallon; in Britain at about 16 cents, and Germany, about 20 cents, including duty. The English consumer obtains almost twice as much gas for the same money as the American; so, from a purely commercial standpoint the conditions are greatly in favor of the English people taking gas in preference to oil or electricity. Special concessions are frequently made to large consumers.

Parliamentary acts mutually benefit producer and consumer. The capital expenditure and dividends on same are regulated. The undertakings are protected against undue competition and blackmailing enterprises. This results in the consumer receiving the gas at the lowest rate consistent with conservative methods of business.

From the tables it will be noted that the candle-power of the gas supplied in England averages 17.39 at 52 cents a 1,000, whereas, in America, the average candle-power is 22, and the average selling price 96 cents. With the present satisfactory state of incandescent mantles, the tendency in England is to still further reduce the candle-power (not "low grade" gas) and the selling price. You may all be conversant with this fact from recent articles on the subject which have appeared in the gas papers and the Proceedings of the Engineering Conference of June, 1903, at the Institution of Civil Engineers. Different gas managers in England have pointed out that, so far as they were able to discern when sending out a low candle-power gas they had no complaints from their consumers, and no one seemed to be aware of the reduction except themselves. From my personal contact with the English engineers, I am of the opinion that a very large majority of them are in favor of supplying low candle-power gas. This English "State of the Art," together with Mr. Glasgow's keen advertising instincts, may account for the unwarranted attack on certain

British gas engineers at the last meeting of the American Gas Light Association. Mr. A. C. Humphreys may possess his soul in peace. Bluff and Rankine's unrecorded arguments are not going to influence Parliamentary legislation.

The advocates of high illuminating power in England have been confined almost entirely to certain persons interested in the manufacture of carburretted water-gas plants and their friends. I believe, for both producer and consumer, the present English conditions favor a low candle-power gas, supplied at a low price, with such calorific value as can be obtained from ordinary gas coal or a mixture of carburretted water-gas and coal-gas of equivalent thermal value.

Do you not think the present conditions in America are favorable for carefully considering the reducing of both the illuminating power and the price, whereby the consumer could obtain more energy for less money, and the gas undertakings a larger revenue from the sale of a greater amount of gas?

While higher wages are paid for labor in America, the quality is better than in England, and fewer men required, resulting in the cost of the gas in the holder being practically the same in both countries. With this promise could we not increase our consumption by reducing the price of our gas, and yet still be able to pay our present dividends (unless there is too much watered stock)?

Why not make a special effort to increase the number of gas engines in use? Also, to replace the present electrical street lighting with up-to-date high-pressure and incandescent gas fixtures by making, if necessary, special concessions for the wholesale amount of gas that would be consumed?

It would seem that a large number of slot meters could be fixed in certain households where at present the ordinary meter could not be trusted to be installed.

English large outputs are traceable to conditions unknown to America. Manifestly comparatively few lessons can be drawn.

DISCUSSION.

President McIlhenny:—We would be very glad to have comments and discussion on this paper. Some portions of it would constitute a very excellent text-book where companies were applying for opposition franchises. I refer particularly to that portion where he states: "The undertakings are protected against undue competition and blackmailing enterprises. This results in the consumer receiving the gas at the lowest rate consistent with conservative methods of business."

MR. OSBOURNE:—I would like to ask some one who knows more about it than I do, just what relation the candle-power bears to the calorific value of the gas? There must be a point where we would have to stop reducing the candle-power when at the same time using mantles, or something of that sort, such as has been the tendency for some years. I have noticed that the tendency has been to reduce the candle-power and at the same time use mantles in the endeavor to manufacture the gas cheaper. It seems to me there is a point where we would have to stop. I would like to ask if any one knows where that point is. For example, in reference to gas engines: Is there any one here from Milwaukee who has had experience in that line? I think the idea of the writer of the paper was to cut down candle-power and at the same time keep up the heating value. There must be, to my mind, a certain point where the heat value would drop, after we cut down the candle-power to a certain point, and I wanted to know where that point was.

MR. DOHERTY:—I could not answer that question off-hand, but the illuminants in our gases have the highest calorific value of all the gases supplied. As soon as you commence to diminish these illuminants you diminish the calorific value of the gas. That, however, goes down slowly, while the illuminant value of the gas goes down very rapidly as you take out a portion of the illuminants or fail to put them in. The depreciation from a 22 candle-power gas to a 14 candle-power gas, for instance, might be a reduction of only 9 or 10 per cent. in calorific value and possibly less; while the reduction in candle-power would be more, say about 34 per cent. In gas engine work we do not know just what goes on inside the cylinder of a gas engine. There was a very interesting paper read by Professor White at the last meeting of the American Association at Detroit, and a paper which you could all read, I think, to great advantage if you have not already read it. The ideal gas for a gas engine would not necessarily be a coal gas. In fact I am inclined to think the commercial efficiency of a gas engine working on gas having a large percentage of illuminants would be less per B. T. U. than it would if that gas is less rich. Many of the illuminants have a low ignition temperature. The compression in a gas engine is limited to the point where you get prematuring, and gas that would be most suitable for gas engine work would be a gas free from hydrocarbons having a low ignition point, and also free from a large bulk of hydrogen, because an excess in carbon also causes premature ignition.

Another matter I might refer to, Mr. President, at that point, which might interest some of the members if they have ever thought along this subject, and that is, that when we speak about gas having a calorific value of, say 650 B. T. U., that does not mean very much. That is the gross calorific value of the gas. Ordinary artificial gas will have from 10 to 11½ per cent. of its total calorific value tied up in the compounds from which it will be given off only at 212 degrees and below; and, therefore, with gas rich in hydrogen, you cannot figure on your gross calorific value, but have to make allowance for the latent heat of vapor of water contained in the combustion product which also greatly influences the flame temperature because of the heat vaporization and the specific heat of the water, and also because that specific heat is probably not consistent but becomes much greater at higher ranges of temperature than it does with CO_2 gas or nitrogen. I noticed that I have startled some of my friends occasionally by telling them that 10½ or perhaps 11½ per cent. of the heat yielded by the combustion of the gas is only recovered when the flue products are carried to below the condensation point of steam.

PRESIDENT McILHENNY:—In these tables one interesting feature is the difference in England in the per capita output of different towns. Take, for instance, the town of Brentford. The per capita output there is 12,032 cubic feet. In other towns it goes down to 4,728, which is in the city of Liverpool. In London, with the South Metropolitan Company, there is an output of 7,640 per capita. In Birmingham, which is a manufacturing town, there is a per capita output of 8,336 cubic feet.

MR. HAYWARD:—Referring to the first city to which you call attention, Mr. President, there is an asterisk containing a foot note. If you will look at the amount per consumer you will find it is only 43,459, while the town right above it, New Castle, runs up to 70,268 per consumer. It is also interesting to note, Mr. President, that the town which sells gas the cheapest, 26 cents a thousand, sells to only 6,176 consumers and shows a per capita output of 6,986 cubic feet and averages 39,000 feet per consumer. So that it evidently is not a question of price or large consumption.

MR. C. H. WILLIAMS, Madison, Wis.:—With reference to the calorific value of gas, in catering to gas-engine trade and the heating appliances, you have to take into consideration the available heat that the consumers are buying, and if you have a gas of only one-half the heating value per foot you have quite a different investment to take care of in your distributing system than you would if you were distributing gas of a higher calorific value.

Mr. Knight:—It seems to me that the very first statement in this paper may be wrong. I do not see why it follows necessarily that the per capita wealth of most countries is proportionate to the amount of gas consumed. In those cities I am familiar with the per capita amount of gas consumed depends largely on the work done to get the business. It also seems to me that these tables show a very low consumption as compared with the United States. I am sure that the average gas output in the state of Michigan shows a greater per capita consumption than these figures show. I think it would be unfortunate to have the statement go out that they buy twice as much gas for the same money in England as they do in this country. I think somebody ought to write a paper on the same subject next year, from a different standpoint.

It was then moved, seconded and carried that a vote of thanks be extended to Mr. Westcott for his very valuable and interesting contribution.

President McIlhenny:—The Secretary will write a letter to Mr. Westcott thanking him for his valuable paper.

The next paper on our program is "Care of Station Meters," by Henry R. Cartwright, of Philadelphia, Pa.

CARE OF STATION METERS.

HENRY R. CARTWRIGHT.

In numerous papers that have been prepared and read in the last few years at the various gas conventions, I have observed that a subject which has not been touched upon, and which is a most vital one at times to the gas-engineer, is the proper care of the station meter. It, therefore, occurred to me that a few words on this subject might not be amiss.

It is hardly necessary, I think, to enter into a detailed description of the construction of the station meter, but in a broad way it may be described as a strongly braced tinned iron drum, revolving upon a shaft or axle, the drum being divided into three or four compartments, each compartment having a carefully measured capacity, and which fill and empty with gas and water alternately, as the drum is revolved by the pressure of the gas.

Station meters are built upon very careful mathematical lines, and that being the case, are unvarying in their registration if the conditions are normal.

The station meter having been properly set and leveled on solid foundations, the outside cast-iron case will require no further care excepting, possibly, an occasional coat of paint. It is obvious that the drum constructed of tinned iron is the vital part of the station meter. The drum is sometimes covered with tar or paint, but the utility of this depends upon the quality of gas passing through, some gases containing chemical properties which destroy any known paint.

The journals carrying the central shaft are usually made of bronze metal and in most cases require but little attention, the water, and a certain quantity of oil which is generally deposited from the gas, being a sufficient lubricant, but in large station meters the journals are usually fitted with oil pipes which run to the outside of the casing and through which oil may be given if required. While there are no such pipes and it is desirable to oil the journals, this may be done by lowering the water below the center of the meter and then introducing a quantity of some good lubricating oil which will float on the top of the water and reach the journals as the water is gradually raising again in the meter. When dry gases are measured in which there is no condensation of oil, it is well to introduce some of the oil in the meter, a sufficient quantity being used to cover the surface of the water.

The drum should be tested from time to time for leaks. In the absence of a suitable test meter this may be done with a dry meter, or it may also be done by shutting the gas off from the station meter, sealing the valves with water to make sure that the gas is entirely closed off and then running a supply of gas to the inlet of the meter and giving the drum a complete revolution. This gas should be fed with a small pipe, and if there is a leak in the drum as large as the pipe used, the drum will stop when it comes to that point. If this test shows a leak, it would then be necessary to open the meter, locate and repair the leak. Should the leak be in the dry-well, which carries the gas from the inlet pipe up through the water to the drum, the leak will usually be detected by the loss of water from the meter and a corresponding increase of water in the drip from the inlet pipe. The intervals elapsing between the times necessary for the cleaning of the water vary according to the kind of gas passing through, and also upon the degree to which that gas has been purified.

I have known station meters to run from 12 to 15 years without cleaning, while others have collected enough deposit, such as naphthalene, in one year, to prevent the drum from turning. The larger sizes of station meters have plugs fitted in the drum which are reached by removing the hand-hole cover on top of the meter and turning the drum by hand until the plug arrives at the opening. This turning of the drum is made much easier if the water is lowered sufficiently to unseal the drum—for example, from six inches to one foot, in accordance with the size of the meter. These plugs should always be out when the meter is being filled with water, or when the water is being taken from the meter.

At times grinding or pounding noises are heard inside the station meter when in operation, and these noises may arise from several causes, such as a break or buckle in the plates of the drum or from the drum centers being slightly loose on the shaft, or from a somewhat worn journal upon which the end of the shaft would climb to a certain point and then slip back into place.

The train of gears on the inside of the meter sometimes wears out, but as a usual thing require but little attention. If the meter is opened at any time, a little tallow placed upon these gears will be found advantageous.

The stuffing box which carries the spindle running through the front head of the meter, should be examined occasionally and repacked if necessary. Leather washers, yarn, tallow and graphite make a good combination, although there may be more suitable packing for use with certain kinds of gas, but in packing the stuffing boxes, care should be taken not to pack too hard. A leak at that point sometimes does injury to the index over which it is situated.

The cocks, or valves on the water-line and pressure gages, should be opened and closed occasionally, and if there is trouble with dirt in the glasses it is well to leave them open only far enough to admit the pressure, thus excluding some of the dirt by lessening the circulation. This will also prevent the excessive fluctuation of water in the gage glasses. The overflow gage on the back head of the meter is designed to keep the water inside the drum at the proper level. In order that this gage may work effectually, all of its openings and connections should be of large size and kept clear of obstructions. The top of the over-flow gage should be connected to the inlet pipe of the meter only, and the bottom should be trapped close to the gage. This trap should be allowed to discharge into a funnel, and in no case should it be connected to a waste pipe which runs below the level of the meter, as this will frequently syphon the water from the meter.

The stream of water that is fed to the meter to keep a correct water level, should be very small, just enough water being introduced to keep the discharge pipe of the overflow constantly dripping.

The care of the index should be on the same lines as that bestowed upon a clock, and if oil is necessary, it is desirable to use the proper kind of oil, which can be procured from any clockmaker.

There should be a pressure gage on the inlet pipe of the meter and one on the outlet pipe, the difference between these indicating the working pressure of the meter. This differential pressure will increase as the speed of the meter increases, but should never exceed 1.5 inches. If it does, either the meter is working hard from some cause that should be remedied, or is being worked beyond its capacity.

The water pipes for filling and emptying the meter should be as large as possible, as otherwise much time is lost when it might be necessary to fill or empty the meter quickly.

As a final suggestion I would say that it is well to examine your station meter during the warm weather to see whether it is in a proper condition to run through another winter, as the meter is often in or near the office, and it is more pleasant to have the examination made in the season of open doors, as the necessary dirt, odors and noise which attend the possible repair of the meter are then lessened.

When the meter has been opened for examination extreme care should be used to allow no one to approach the meter with a light of any sort, as it takes some hours for the meter to become emptied of gas. The explosive combination of illuminating gas and air begins with 5 per cent. admixture of the gas in the air and ends with 15 per cent.; the most dangerous point being about 10 per cent. admixture of gas. It will, therefore, be seen that the caution about taking a light near the open meter should be strictly observed until the meter is completely emptied of gas.

I think, in the foregoing, that I have covered, in a general way, all of the points which should be observed in the proper care of the station meter. Of course, at times, unlooked-for complications arise, which cannot be guarded against, and the methods for the correction of which must be determined as occasion requires.

MR. CARTWRIGHT:—In addition to what I have already said in my paper I would mention the fact that it has come to my knowledge that a 10-foot station meter is now in use in Birmingham, Ala. This meter was built in 1887 and has recently been opened and a half a barrel would hold all the deposit that was found in it. This, of course, speaks well for the purification of the gas and also the purity of the water.

DISCUSSION.

PRESIDENT McILHENNY:—This is a subject about which inquiries are often made. We would be very glad to have a discusion upon it, or any information which any member may desire, I am sure, will be furnished by Mr. Cartwright.

MR. MALONE:—There is one paragraph in Mr. Cartwright's paper which says: "This differential pressure will increase as the speed of the meter increases, but should never exceed 1.5 inches. If it does, either the meter is working hard from some cause that should be remedied, or is being worked beyond its capacity."

I would like to know how much beyond the rate of capacity of a station meter it would register accurately? If the gentleman could answer that question I think it would be of value to all of us. The reason I asked it is that we are operating a meter at the works with which I am connected which is rated at a million feet and we have measured considerably beyond that rate.

MR. CARTWRIGHT:—The rate of capacity of a station meter is always made on a very conservative basis. It depends upon several things, such as the size of your inlets and outlets and also the form of pressure you use in your gas. When I say the pressure should not increase over 1.5 inches, it means if it does the meter is liable to blow, and if increased to too great an extent it will break the seal. If the overflow is working properly, the water will pretty nearly take care of excess over rating, so that you will get a comparatively accurate measurement up to, I suppose, 3 or 4 inches pressure, supposing the overflow to be working so that the water rises on the inside of the drum in proportion to the pressure.

Mr. Butterworth:—I rise simply to express my admiration for the paper. I think it is excedingly well written, in the first place; and, in the second place, it gives some very valuable and practical suggestions with reference to a character of apparatus which, as he says, we have not touched upon in our various meetings as much as its importance deserves. I therefore move that a hearty vote of thanks be extended to Mr. Cartwright for his very excellent paper.

The above motion being duly seconded, was adopted.

President McIlhenny:—We will next take up the Progress Department, and I will ask the editor, Mr. Irvin Butterworth, of Detroit, Mich., to read it.

PROGRESS DEPARTMENT.

IRVIN BUTTERWORTH, EDITOR.

Having been re-elected by you at your last meeting to serve as editor of your Progress Department for another year, I herewith respectfully submit a *resume* of the more important technical and mechanical improvements that have been made in gas manufacture, distribution and consumption since we last met, so far as I have been able to ascertain and describe them.

My report of a year ago attempted to cover the developments of the preceding five years. Allowance must therefore be made if my present report should seem relatively meager, or if the progress recorded therein should not be so great or important as that disclosed by my former report. As a matter of fact, the advancements of the past twelve months will compare very favorably indeed with those of any preceding year in the history of the gas business, and their contemplation will dispel any misgiving lest the technique of gas manufacture and distribution is not keeping pace with the rapid progress that is now being made in the commercial end of the business.

Patents.—We are indebted to Frederick Enger for the information, which he has obtained for us by personal and painstaking research in the Patent Office at Washington, that the patents pertaining to gas manufacture and distribution that were issued by the United States Patent Office during the past year were fully one-half as many as were granted during the entire period prior to 1888. He also furnishes us with the following itemized list or classification of the gas patents issued during the past year which is extremely interesting as indicating the present trend of gas invention of this country:

Gas engines or gas engine attachments	217
Acetylene gas (mostly generators)	81
Incandescent gas burners or appliances	52
Gas-making process (mostly producer gas)	46
Gas governors and valves	31
Heaters and stoves, or burners for same	30
Purifiers and a few coke ovens	27
Air-gas machines, or appliances for same	8
Inclined retorts	4
Coke conveyors	3
Gas analyzing apparatus	2
Miscellaneous (burners, cocks, lamps, meters, etc.)	123
Total	624

It is most interesting also, in this connection, to know that in Great Britain during the past year 310 patents relating to the gas business have been issued, as against 240 in 1902 and 259 in 1901. While the greatest number pertained to incandescent gas lighting, and the next greatest to gas engines, yet a review of the British patents is significant in showing that much more attention than for many years is now being given to improvement in gas-works plant and processes.

It is evident that there has been unusual interest and activity in gas invention during the past year on both sides of the water. Progress in the development of the gas engine has been especially marked, due largely to its increasing use with producer and blast furnace gases, but partly also to the expiration of the principal Otto gas engine patents. Acetylene generators still constitute an attractive subject for the inventor, and incandescent gas burners and appliances carried off third honors in this country in the number of gas patents issued. However, the greatest progress in the gas business is not necessarily in the direction indicated by the largest number of patents issued. As stated above, the most important progress of the past year (aside possibly from that made in gas engines) has probably been in gas works plant and processes, particularly in respect to machinery for charging and drawing retorts and for conveying coal and coke. The number of byproduct coke oven plants is also increasing, and this system is a factor of growing importance in the matter of gas supply for larger cities. Improved methods of distribution, including the high-pressure system, are being rapidly adopted and out-door incandescent gas lamps have been greatly improved and developed during the past year.

Additional Gas Appliances.—The number and variety of industrial gas appliances are also rapidly increasing, and the scope and possibilities of this branch of the gas business have been strikingly shown by the recent publication by a Western gas company of an industrial gas appliance catalogue which, by its magnitude and completeness, is a revelation to gas men themselves of the adaptability of gas to innumerable industrial purposes. Last year's Progress Report contained a list of a large number of industrial uses to which illuminating gas is being applied, and this list may now be increased as follows:

Heating pipe-dipping,
Relining locomotive cylinders,
Welding tires of small express wagons,
Matrix drying,
Heating macaroni presses,
Rosin melter for bicycle manufacture,
Tinning and galvanizing furnaces,
Sweep reducing furnaces,
Instrument sterilizers,
Dressing sterilizers,
Water sterilizers,
Bottle sterilizers,
Barbers' sterilizers,
Crematory for hospital refuse,
Barrel heaters,
Small hot air engines,
Core drying ovens,
Mould drying burners,
Carving tables,
Ham and meat broilers,
Rendering kettles,
Turkey roasters,
Inside heated soldering irons,
Coffee roasters,
Pop-corn poppers,
Drop carving machine (for furniture making),
Can capping and tipping machines,
China kilns,
Fruit Incubators,
Incubators,
Steam generators for drying-tables, etc.,
Varnish boilers,
Tube soldering furnaces,
Leather-sewing machines,
Process leather machines,
Steam cloth sponges,
Operating vapor baths, etc.

The above list, added to last year's, makes a very suggestive array of present industrial gas uses. Some of the gas companies of this country, including at least one large one, are now selling as large a proportion as two-thirds of their gas for purposes other than illumination, with a satisfactory increase also in the illuminating branch of their business.

Another manifestation of the present tendency toward progress is the intelligent and careful attention which gas companies are beginning to give to the daily operation of their coal-gas benches with respect to their fuel consumption, the largest single item of gas-works expense. Until recently, flue gas analysis, as a means of securing maximum fuel economy in gas-works, was almost unheard of and seldom practiced, but now, and especially within the past year, many gas companies are making daily or frequent flue gas analyses, to their great advantage.

The adoption of at least tentative standard specifications for testing fuel gas appliances, which is a reform consummated within the past year, is a significant and important forward step. And last, but not least, there has been a marked and much-needed improvement in the working methods of some of the gas associations of this country.

The following are some of the specific improvements of the past year:

Charging and Drawing Machinery.—During the past year there have been great interest, progress and development in all kinds of gas-works machinery, especially charging machinery. In this country, aside from the companies operating inclined retorts and by-product coke ovens, those in the following cities are now using drawing or charging machinery, or both, as shown by the following list:

Charging machinery only: Montreal.
Drawing Machinery only:
- Cleveland,
- Indianapolis,
- Newark,
- Worcester,
- Buffalo.

Both charging and drawing machinery:
- Cincinnati,
- New York,
- Toronto,
- Philadelphia,
- Mt. Vernon,
- Detroit,
- Milwaukee.

The following makes of machines are now in use in this country:

The Bronder, charging and discharging.
The Ross, charging and discharging.
The West, charging and discharging.
The Arrol-Foulis, discharging.
The De Brouwer, charging.

Charging machines are now being operated in this country that charge four retorts simultaneously, and discharging machines are operated that discharge four retorts simultaneously. Combined machines are also being made that both charge and draw, as may be required, either three or four retorts simultaneously. In Europe especially there has been great activity during the past year in the development of charging and drawing machinery The latest forms of charging machines do not convey the coal into the retorts, but "project" it in either by centrifugal blowers, turbines or fans, or from a rapidly moving belt. Retorts 20 feet long are being successfully charged in this way, notably at La Villette Works of the Paris Gas Company, where an electrically-driven turbine projector is used. The De Brouwer projector is in operation in the cities of Bruges, Belgium and Derby, England, and perhaps elsewhere. It is electrically driven, and throws the coal into the retorts from a rapidly moving horizontal belt, on to which the coal is fed from an elevated hopper. A machine of this make is now also being used, experimentally at least, in New York City. A firm in Stuttgart is also building what they call the "Kobold" charger, which can also be operated by electricity, and which throws the coal into the retorts by a system of rapidly-revolving fans. Other types of centrifugal projectors for charging retorts are also being perfected, such as the Fiddes-Albridge and Wise machines, both patented in England last year.

The claimed advantages of this general method of charging are that—

First.—It is adapted to small gas-works;

Second—The coal is placed with absolute evenness and nicety in the retorts; and

Third.—Retorts of any length, within reasonable limits, can be charged by the same machine.

There seems to have been less activity in the development of discharging machinery than of charging machinery, but a notable improvement in the former is the discharging ram now used at La Villette Works in Paris, and in Derby, England, which pushes the coke out of the through retorts from one end. Notwithstanding the retorts are 18 and 20 feet long, the coal is charged with such evenness by the turbine and belt projectors that the coke can be easily pushed out in this manner, as it could not be with any other system of charging. Furthermore, the retorts can be almost completely filled with coal, resulting in obvious economies and advantages. In these works the projector is operated at one end of the retorts and the discharging ram at the other.

Inclined Retorts.—The advance made in machines for charging and drawing horizontal retorts has rendered the wisdom of installing inclined retorts still more doubtful than it was a year ago. Engineers are proceeding cautiously, and it seems to be the part of conservatism just now to await the developments of the immediate future before adopting on a large scale either of the two systems, although the chances are apparently in favor of the horizontals. In England only seven patents pertaining to inclined retorts were taken out last year, and only one of them refers to the retorts or settings proper, the others pertaining to buildings, conveyors, etc. Only four inclined retort patents were taken out in the United States during the past year, and they were obtained by foreign inventors. However, some notable advances have been made during the year, both in this country and in Europe, in the utilization of old retort houses with low roofs for the installation of inclines that were previously supposed to absolutely require high roofs. During the past year the inclined retorts built during the previous year at Lynn, Mass., have been put into successful operation, and inclined installations have been built during the year at New Bedford, Mass., and Lynchburg, Va., the latter being the smallest installation of the inclines in the country, *viz.*, three benches of 6s. A low-roofed retort house is used and the retorts are to be heated by producer gas made in isolated producers outside the building. The Consolidated Gas Company of New York City is about to install an inclined retort plant having a daily capacity of 10,000,000 cubic feet.

Through Retorts.—With the advent of improved charging and drawing machinery there are evidences of a revival of the through retort construction. One retort builder in this country is now prepared to erect through retorts 20 feet long, adapted to the use of a charging machine at one end and a discharging ram at the other.

Vertical Retorts.—An interesting and promising experiment has been in progress during the past 18 months at Exeter, England, with the revival of an old idea of placing the retorts in an upright instead of in a horizontal position. Only one such retort was originally installed for the purpose of this experiment, but the results are so favorable that an installation of six such retorts is now being made at these works. The coal is fed into the retort by a plunger which introduces about 6 pounds of slack every 100 seconds. This installation is what is called the "Settle-Padfield" system. Another system of vertical retorts is also about to be tried in England, while a third installation on still another system has been determined upon at one of the Berlin gas works. The results at Exeter indicate that an increased yield per ton of 2,000 to 3,000 feet of gas may eventually be secured by the vertical system.

Small Retorts.—During the past year a multitubular retort setting was patented in England, contemplating the placing of a large number of very small horizontal retorts in one bench, with the view of obtaining higher yields and better qualities of gas. A bench of 20's has been installed at East Greenwich.

Bench Construction.—One bench builder has perfected plans for benches of horizontal 8's so constructed that he claims that no clinker will be formed and that there will be no danger of cracking flue tiles while renewing the retorts and settings. The subject of better grades of fire-clay goods for benches is being agitated by several companies, and there will doubtless soon be much improvement along this line, as indeed there has been during the past year. One manufacturer is already putting four different kinds of materials in his bench work, varying the quality according to the usage or exposure to heat to which the different parts are to be subjected.

A new form of recuperator tile has also been patented in this country, the tiles being interlocked, thus protecting the joints and making a simple, solid and tight construction.

The Crystal Palace Gas Company in London is now making its own fire-brick and fire-clay specials, with apparently economical results.

The main flue in inclined benches is now being placed inside instead of outside the benches, thereby economizing floor space.

There have been some improvements in the iron work of benches during the year, particularly as to the method of anchoring the buck-bars at the bottom and tying them together at the top. Attempts are being made to standardize and reduce the number of different sizes of mouth-pieces. Two or three companies having retorts in vertical rows have connected each row of mouth-pieces with one straight standpipe, which greatly facilitates the cleaning of the standpipes. One of these companies has a patented pneumatic standpipe cleaner for cleaning these straight pipes. It is suspended from the roof trusses and is very successful in its operation, keeping the standpipes perfectly clean with a minimum of time and expense.

A new device has been perfected during the past year for scurfing retorts. It involves the simultaneous introduction into the retort of a combination of steam and compressed air, and by its use the carbon in a retort is loosened up in less than one hour.

Producer Gas.—Progress has been made during the year in the manufacture and application of producer gas, but for prudential reasons announcement cannot yet be made of some of the improvements. Standard producers are being arranged for the use of bituminous coal, and there has been introduced a small suction gas producer, using anthracite or coke of sizes as low as 10 horse-power. These suction producers operate without a gas holder, and are coming into special favor in Germany and France. Several plants are now making producer gas out of wood. Methods of producer gas manufacture are becoming more flexible, adapting the plants to the manufacture of various kinds of gases according to the purposes for which they are to be used.

Coal and Coke Conveying Machinery.—There has been considerable progress during the past year in the development of telpherage and other systems for conveying coal and coke. A movable telpher track now permits the storing of coal or coke in either rectangular or circular spaces and taking it from same to boilers, etc. Coke conveyors combining the use of exhaust fans for withdrawing the steam and smoke, the coke being quenched while in the conveyors or otherwise, have been improved during the year. The application of electricity to conveyors handling coal, coke and ashes in straight lines, curves and up grades, is a development of the past year. The cost of maintenance of conveying machinery is being decreased, as well as the power of consumption. In one works all the coal and coke products are handled automatically by electric motors. During the past year one gas works in this country has installed an electric storage battery locomotive for handling the cars on the tracks and about the works.

Tar, Naphthalene and Cyanogen Extractors.—There have been improvements in the drum of the P. & A. tar extractor, and other forms of tar extractors have also been improved somewhat. Two different concerns in this country are preparing to build naphthalene extractors. The reversible condenser invented a few years ago by Charles Carpenter, of the South Metropolitan Works, London, England, for the extraction of naphthalene, is still in successful use. No American gas companies are as yet recovering the cyanogen from their gas, although one concern in this country is prepared to build apparatus for this purpose. There seems thus far to be more theorizing than practice, the world over, in the matter of the extraction of cyanogen. Authorities are still arguing as to whether cyanogen can be produced more cheaply by synthetic methods than by extraction from gas, and certain other authorities are warning gas men of the limitations of the world's market for cyanides.

Ammonia Washers—Every year seems to mark some improvement in ammonia washers as made by the various manufacturers. One concern has just brought out a washer that seems to carry the refinements of this apparatus further than ever before, subdividing the gas into extremely small jets, giving it a double washing and yet permitting so low a velocity that but little entrained water is carried forward with the gas. Washers of other makers have been similarly improved. The rotary brush scrubber has also been improved in some details, such as the adjustment of overflows to prevent the liquor in one chamber from mixing with that in the next, means for the quick removal of the brushes, and so improving the brush construction as to increase the actual scrubbing surface.

Water-Gas Apparatus and Processes.—During the past year one manufacturer has improved his carburetter by making it of larger diameter (the same size as the generator) and placing the up-take flue inside the carburetter instead of outside, as heretofore, the bottom of this flue constituting a large ash-receiving chamber, which is fitted with a cleaning door at the bottom. This improvement enables the carburetter and superheater to be placed closer together, permitting shorter connections, and making a neater appearance. A blast box is now placed on the side of the shell immediately above the internal flue, from which the air is forced in at a right angle with the ascending generator gas, contributing to a uniform distribution of the combustion over the entire surface of the checker brick. The former divided blast arrangement has been further improved by the addition of special steam distributors between the bearing bars, insuring uniform distribution of the steam under the entire surface of the grate. Another firm of water-gas apparatus manufacturers has brought out what they call "twin generator apparatus," for the manufacture of low grade water-gas. A useful and suggestive paper was presented during the past year by G. W. McKee, to the Canadian Section of the Society of Chemical Industry, on "The Economic Admission of Steam to Water-gas Producers of the Lowe Type." The author calls attention to the economical results to be obtained by gradually diminishing the admission of steam during the run. During the past year the claimed advantages of the Lewes system of passing blue water-gas through coal-gas retorts during carbonization have been challenged, and Walter R. Jones, engineer of the Rome Gas Works, has patented a method of gas manufacture that exactly reverses the Lewes method in that he introduces coal-gas into the water-gas generators, where the mixing of the gases takes place, and the combined gases are then taken to the superheating chambers, where the hydrocarbons are fixed in gaseous form. It is claimed that economies are thus obtained by the enrichment of the gas with the hydrocarbons of the tar. I have obtained no data as to improvements in the Dellwik-Fleischer system of water-gas manufacture, but the following quotation from a paper contributed last October to *The Engineering and Mining Journal* will be of interest: "The water-gas plant mostly used in Europe is the Dellwik-Fleischer system, over 80 plants of that type being in continuous operation. By this process water-gas costs less than by previous processes, the yield being 35 to 40 cubic feet per pound of coke or anthracite. The working of the apparatus is safe and simple."

Fuel Economizers.—The manufacturers of a well-known fuel economizer adapted for use in connection with water-gas plants, report that they have made several improvements therein during the past year. At Madison, Wis., 12 per cent. of the boiler fuel is saved by heating the boiler feed-water with the exhaust gases from a large gas-engine that is used for generating electric current.

Oil-gas Apparatus and Processes.—These are used chiefly in California with the heavy oils now being produced there in large quantity. The gas-works employing the latest oil-gas apparatus use no solid fuel whatever, except the coke that is made from the oil itself in the process of manufacture, which coke is used under the boilers. During the past year an economical method has been discovered for coking the lamp-black with which the gas made from this oil is heavily charged. The coke made from the lamp-black in an oil-gas works having a capacity of 30,000 feet per day or over is sufficient to generate all the steam used in the works. The oil-gas apparatus, as made by one concern, is simply a modification of the ordinary water-gas apparatus, in which the generator is omitted altogether, its place being taken by two carburetters with special design of checker-brick and burners, and having a scrubber of special design, made necessary by the large quantity of lamp-black which the crude gas contains. The total consumption of oil per 1,000 cubic feet of finished gas is about 11 gallons. About 40 California cities and towns are now being supplied with this oil-gas, some of them among the largest in the state, and the total increase in oil-gas production during the past year is about 2,000,000 cubic feet per day.

Exhausters—No radical improvements in exhausters have been made during the past year, but some very large units have been built. One that has recently been installed in a gas-works in a large western city has a displacement of 52 cubic feet per revolution, and is direct-connected to a high-speed Westinghouse gas-engine of 300 horse-power, designed to run at the rate of 200 revolutions per minute against a five-pound pressure, pumping 8,000 to 10,000 cubic feet of gas per minute into medium-pressure gas mains. Another large exhauster built last year has a displacement of 300 cubic feet per revolution, is designed to operate against four pounds pressure and weighs 140,000 pounds. Experience is said to show that these large units operate against pressures up to five pounds with about 75 per cent. of the power required for piston machines of the same capacity. A Pittsburg concern has brought out a new exhauster speed regulator, and the manager of an Eastern gas company has also recently adopted an improved device for this purpose.

Purifying Boxes and Apparatus.—Each passing year shows some advance in purifying apparatus. The use of dry-seal boxes is increasing, and considerable improvement is being made therein. The placing of purifying boxes out of doors is also increasing, two large gas companies in this country having built such outside boxes last year, leaving them entirely unprotected and exposed to the weather with no bad results. The fact seems, therefore, to be still further established that purifying houses are unnecessary. An English gas company has effected a saving of 10 to 15 per cent. in first cost of the usual four-box construction by leaving no space between the boxes, and by putting the center valve above the boxes where the four inner corners meet. A large gas company in this country erected during the past year an out-door box of novel construction, resembling the upper-lift of a gas-holder, no iron whatever is used in the interior of the box, the usual trays being dispensed with and the oxide being supported by wooden slats resting on wooden supports. The box is filled and emptied through doors in the side. In two other American cities novel forms of purifying trays were introduced, consisting of two layers of boards placed flatwise, the two layers being separated by cleats, or slats, of wood, and the boards in the top layer covering the joints or spaces between the boards of the bottom layer. A large manufacturer of trays reports that the tendency is strongly toward heavier trays, 1.5-inch to 2-inch, instead of 1-inch, as formerly. Cement purifiers were built during the past year in two or three cities in this country, saving their owners from 33⅓ to 50 per cent. in first cost as compared with the usual iron box construction. Improvements in valves and systems for reversing the flow of gas through the boxes have been made during the past year, these systems now being made very flexible, permitting the handling of the gas in a great variety of ways as circumstances may demand.

Prospective Processes.—There is some quiet talk on both sides of the water about the proposed manufacture of gas similar to natural gas, consisting chiefly of methane, or marsh gas, and a patent was taken out in England last year on a process of this sort. Another process is promised that will completely gasify any carbonaceous material. The Mazza separator, an Italian invention, is being discussed, which is said to enrich air with oxygen by a centrifugal mechanism that takes advantage of the different gravities of the constituents of the atmosphere. The inventors claim that a saving of 22 per cent. in boiler fuel has been effected by supplying the boiler with air thus enriched.

By-product Coke Ovens.—Improvements during the past year in by-product coke-oven apparatus consist of machines for leveling the coke in the ovens, formerly done by hand, and an apparatus for the more effective control or separation of the gases evolved in the coking process, especially when a portion of same is to be used for illuminating purposes. There are now 341 more ovens in operation in this country than there were January 1, 1903. Several thousand by-product coke ovens are now being built in Europe, and the following is a list of new ovens now being built in this country, including additions to plants already in operation:

Buffalo, N. Y	564
Chester, Pa	40
Chicago, Ill	120
Cleveland, Ohio	66
Duluth, Minn	50
Dunbar, Pa	30
Geneva, N. Y	30
Lebanon, Pa	90
Milwaukee, Wis	80
South Sharon, Pa	140
Tuscaloosa, Ala	40
Total	1,250

Tar.—Some use has been made of tar in Europe during the past year for laying dust on roads. The use of tar for the manufacture of tar macadam for street paving purposes is also increasing in this country. Experiments are being made, with promising prospects, in the use of tar for the manufacture of briquettes for fuel. The American Coal Products Company estimate that the total tar production of 1904 in this country will be 40 per cent. more than it was in 1903.

The manufacturers of a well-known bitulithic pavement report the increase in their business as follows:

1901	14,400	square yards.
1902	255,000	"
1903	901,000	"

Quick Sulphur Determination.—Two or three methods of making quick sulphur determinations of coal and coke are being or have been developed during the past year, and one of them is described in *The American Gas Light Journal* of June 11, 1903, which admits of two or three complete determinations per hour. One of the other methods will be announced later this year by the discoverer.

Photometry.—There seems to be nothing new in the way of photometry beyond the increasing interest in the Simmance-Abady "flicker" photometer, the principle of which was discovered by Prof. O. N. Rood 10 years ago, but the photometer itself not having come into prominence until within the past year or two. It is a very interesting instrument, said to reduce the "personal error," and to enable the operator to accurately measure the relative intensities of two sources of light of different qualities or colors. The increasing use of incandescent gas lighting and electric arc lighting has made a photometer of this sort a desideratum. Only one of these instruments, so far as I can ascertain, is now in use in this country, and the operator is by no means pleased with it, although foreign gas journals and gas men speak very highly of them. The International Photometer Commission is still engaged upon the task of fixing upon a standard method of photometry, but thus far seems to be doing preliminary work. There is now being perfected in this country a device for making rapid candle-power determinations, but as it is not yet complete no report can be made upon it at the present time.

Since the above was in type, I have received the following from Prof. C. P. Matthews, of Perdue University:

"Marked progress has been made in industrial photometry during the past year. The advance has been along two lines, namely ,the perfection of photometric methods, and the establishment of a working standard of light. Improvement in photometric methods has been chiefly in the perfection of photometers which yield the mean spherical candle-power at one sitting, thereby shortening the process of making a spherical measurement from several hours to as many minutes. As the spherical candle-power of the light source is, after all, the true measure of its efficiency as an illuminant, this must be considered as a marked step in advance.

"With reference to the second line of progress, it may be said that The Electrical Testing Laboratories, in New York City, are issuing standardized incandescent lamps that yield a candle-power in close accordance with the Reichs-Anstalt standards, which are accepted as the most reliable in existence.

"The situation as regards a primary standard of light remains unchanged, but pending the development of a satisfactory primary standard of light we are able to maintain, thanks to the National Bureau of Standards of Washington and the New York laboratories above referred to, a working standard of light that will have all necessary constancy and ease of reproduction."

Gas Distribution.—The past year has witnessed an increased use of high-pressure gas distribution, which seems to be coming into general favor. No noteworthy improvements, however, have been made in the appliances used in this system of distribution.

One company has devised a very simple but effective high-pressure street lamp regulator. In a large Eastern city bell-and-spigot cast-iron pipe is being laid for the transmission of gas at 10 pounds pressure, the pipe being tested at 20 pounds. In a large city in the middle west gas is being distributed through three different systems of piping, each at a different pressure, the suburbs being supplied with very high-pressure gas through small wrought-iron mains, and the extremes of the low-pressure system being reinforced by special cast-iron feeders from the works, carrying gas at 5 pounds pressure, automatic reducing pressure governors being used where these systems connect into each other. In Greeley, Colo., a novel high-pressure system of both manufacture and distribution is in experimental operation. The gas is of about 100 candle-power when made, and is then pumped into a tank at 120 pounds maximum pressure, whence it is passed into the distributing holder which automatically injects sufficient air into the gas to dilute it to 20 candle-power before it passes on to the consumers through 10 miles of small distributing mains.

Meters.—No improvements have been made in gas meters during the past year beyond those pertaining to factory details, except some minor improvements on the drums of station meters. A patent was taken out in England on an improvement in the rotary meter brought out a year or two ago. A well-known prepayment attachment has been improved by the addition of a device (furnished only when ordered) which is said to prevent attempts to "beat" it. The use of the prepayment attachment and of the prepayment meter is said to be increasing. The manufacturers of the straight-reading meter dial, referred to in last year's Progress Report, will be ready to make deliveries the latter part of this month. Ordinary meters equipped with these dials will cost 30 cents extra. A meter has been brought out in England that simultaneously records the quantity and pressure of the passing gas.

Incandescent Gas Lighting.—The following improvements and progress have been made during the past year in incandescent gas lighting and appliances:

1. Increased use of the yellow or mellow-tinted mantle in place of the white.
2. Increased use of high grade mantles and of mantles equipped with carriers.
3. Mantles are gradually being strengthened and hardened, making them less fragile and longer lived.

4. Adjustable gas checks of various makes are coming into more general use, conducing to better results under varying pressures.

5. Improvement in the materials of which chimneys are made, conducing to their more general use in place of the so-called "cylinder" chimneys which give lower efficiency.

6. Increased use of small mantles and burners, consuming half as much gas and giving half as much light as the ordinary sized mantle and better adapted to domestic and decorative lighting, also producing less heat and discoloration.

7. Center pilot-jet by-pass, which produces a flame less likely to be blown out than with the older form, burns an extremely small quantity of gas, and automatically turns low while the mantle is burning full.

8. Development of large units burning 6 to 12 feet of gas, specially constructed for use with air-hole chimneys, the shades being supported by side rods independently of the chimneys. The air holes in the chimneys throw the surrounding air directly upon the mantle, permitting the consumption of more gas, producing a larger light, but with a sacrifice of efficiency.

9. Improvement in out-door lamps as follows:

Ball-and-socket joint, that serves as an anti-vibration device decreasing the breakage of mantles and greatly facilitating the hanging and trimming of the lamp.

Arrangement for protecting mantles while trimming.

Means for easily renewing one mantle without exposing the other three.

Easy means for cleaning feed-pipe and globe.

Arrangement for hanging globe on supports while trimming lamp.

Device for preventing wind from producing down drafts through the lamp.

Air ports of Bunsen tubes protected by gauze, thus preventing the flashing back of the flame.

Easy removal of globe without the removal of the globe holder.

A guard for protecting the mantles from breakage by the removal of the globe, or by wind.

Drip cup for condensation.

10. A new adjustable burner, known as the Tirrill, made in New York.

11. The Lucas lamp mentioned in last year's Progress Report has been improved and is now made in units as large as 1,000 candle-power.

12. The invention of the "Millennium" high pressure and high candle-power lamp, made in very large units and now introduced considerably for lighting streets in Germany, with very promising success. The larger sizes consume as much as 42 feet of gas per hour, yielding 1,315 candle-power.

13. The invention of the "Taj" burners, running as high as 1,000 candle power.

14. The improvement of the Plaisetty mantle, which promises much for toughness, durability and high candle-power.

15. The d'Heureuse mantle, which is woven instead of knitted, resulting in greater strength and increased ability to withstand shocks and minimizing shrinkage.

16. The development of the Scott-Snell lamp for street lighting, the water-chamber being discarded, and the lamp being otherwise improved. This system is being tried in several English cities with promising results.

17. The increase in the adoption of the inspection and maintenance system of looking after mantles and burners by gas companies. The South Metropolitan Company of London now has a force of about 70 men engaged at this work.

18. The development of the Keith system of intensified incandescent gas lighting, which also is being introduced in England.

19. The development and improvement of various other makes of high candle-power lamps.

20. A system of lighting and extinguishing gas street lamps by raising and lowering the gas pressure has been perfected in England, which has thus far successfully withstood practical tests.

21. Better means for regulation of both gas and air supplied to high candle-power lamps.

22. An improvement and cheapening of the mantle which is so made as to automatically light the gas when it is turned on.

23. Inverted incandescent mantle burners have been perfected to a commercial success, permitting decorative effects and producing no shadows. These lamps are about to be pushed in this country.

There seems to have been no improvement or progress in this country in incandescent gas street lamps or burners, or in incandescent gas street lighting. In Europe, however, street lighting by gas is making rapid headway.

Mica Chimneys and Canopies.—Mica chimneys have been improved during the year by so making them that air is drawn in at the base either through perforations near the base or through an open space between the chimney and an inner collar, thus making them adapted to the use of large mantles requiring additional air supply, and they have become somewhat popular. A combined chimney and canopy is also being made of mica for small lights.

Holophane Globes.—Holophane globes were made in greater variety last year than ever, and the finish of the glassware is being improved. Their popularity continues to increase, the manufacturers claiming a gain in sales of 50 per cent. over those of the preceding year.

Gas Ranges.—The following progress in gas ranges can be recorded for the year:

The invention and perfecting of a split-top burner that is said to prevent the flame from "wavering" or producing an odor and which is easily cleaned and cannot leak at the joint.

Valves that are quickly adjustable by the operator to varying gas pressures and so made as to keep the orifices free from foreign substances.

One concern has patented a broiling and roasting screen that slides in immediately under the oven burners and protects the foods from burning and from the smudge and dirt due to dripping fat, etc.

Two concerns have found it best to so change their ranges as to admit of sweeping underneath them, and one of them has devised a drop-oven shelf for the upper oven. Another has improved its oven bottoms, broilers and drip pans, and has substituted steel panels for cast iron in the drop doors. It is also using refined instead of japanned iron for the bodies and to fill a certain demand is also making a plain range, devoid of all ornamentation. Ranges with elevated ovens and broilers are coming into more general use. There seems to be no diminution in the number of gas ranges manufactured yearly and at least two additional factories have been put into operation during the past year.

Gas Water Heaters.—There has been brought out and put upon the market during the year a departure in the shape of an all copper gas water heater in which the gas flame and products of combustion pass through the tubes on the same plan as the steam automobile boiler, instead of the water passing through the tubes as in the ordinary construction. The entire heater is without any casing of any description. The makers are of the opinion that copper or brass are the only materials of which water heaters should be constructed. Another concern has improved its heaters by making the castings thinner. Water heaters are coming into more general use and additional factories are taking up their manufacture.

Instantaneous Water Heaters—These heaters, as made a year ago, have undergone a noteworthy improvement. They are about to be made of sheet steel, however, instead of cast-iron; the change to steel being attended with many advantages, such as lighter weight, less liability of breakage, etc.

Gas Heaters.—One concern has placed upon the market during the past year what it calls "an odorless and base-heating gas stove," in which the burner is overhung with a fire-brick cone that is said to make this form of heater give out a larger proportion of the heat in the form of radiant heat than is done by any other gas heater.

Gas Engines.—As was the case during 1902, the greatest progress in the gas business during the past year has been in the use and construction of gas engines. The following table, showing the number of engines of 1,000 horse-power, or over, manufactured or contracted for by five of the great firms of Continental Europe, gives an idea of the rate at which the use of gas engines is increasing:

Year.	No. of Large Gas Engines.	Total Horse-power.
1900	2	2,000
1901	2	2,000
1902	9	11,400
1903	11	13,100
1904 (contracted for)	62	90,000

Of this list, eight are run on producer gas (seven specified as Mond gas), two on coke oven gas, and the balance on blast furnace gas. The Lackawanna Steel Company at Buffalo are now installing nine 1,000 horse-power gas engines.

Although none of these very large units are used with ordinary illuminating gas, yet the use of small units for illuminating gas is also increasing rapidly. It is stated that 50,000 gas engines of one comparatively recent make are now in use and it is also said that there are now more gas engines being made than steam engines. There has been considerable development in the horizontal double-acting engines of the twin-tandem double-crank design. A considerable number of the latter are being installed for direct connection to alternating-current generators to operate in parallel, which indicates the degree of refinement that has been reached in the matter of regulation. A firm in this country is prepared to build 4,000 horse-power gas engines of this type. One gas engine expert reports that the most significant improvement of the past year is the rapid advance in favor of the two cycle engine which is now receiving great attention, especially in Germany. As to improvements in detail, one concern has adopted a solid cylinder-head which prevents the possibility of water leaking from the water-jacket into the explosion chamber. The cap which covers the cylinder head is also made thin and shell-like, so that if water carelessly left in the jacket should freeze, the jacket-head will burst, thus avoiding damage to the cylinder proper. An auxiliary exhaust has been added, also the strap style of connecting rod, which is less liable to break than other forms and which lends itself to the easy taking up of the wear of the boxes. One engine builder predicts that the two cylinder vertical engine will cut quite a figure in the use of artificial gas, because they are adapted for use in building in densely populated portions of cities where gasoline engines would be prohibited. Considerable attention has been given during the past year to problems relating to the cooling of gas engine cylinders. Compound gas engines have also been tried during the year, but without flattering success thus far. There seems to have been no larger sizes of gas engines made in 1903 than were made in 1902. One engine-building firm in this country is now building a 1,300 horse-power engine.

The current year promises many interesting developments in gas engines, as inventors and experts are busy upon improvements and new types. An experimental engine has been built by one concern, a trial of which indicates that when perfected it will have a thermal efficiency of 45 to 50 per cent.

Many experimentors are working upon the gas turbine, and there are rumors that the problem of a successful gas turbine has been solved, although there is nothing more definite to report as yet. It is said that the General Electric Company is now making extensive experiments with this form of motor.

Electrolysis.—No progress worth mentioning has been made during the year, either in the development of means for the prevention of electrolysis of gas pipes, or by the courts in fixing the responsibility for damages from such electrolysis as between the gas companies and the electric street railway companies. The manufacturer of a well-known coupling recommends it for the prevention of electrolysis of service pipes.

Acetylene Lighting.—That acetylene lighting is making progress is shown by the following figures, which give the number of acetylene town plants installed in the United States in the past six years:

1898	4
1899	4
1900	10
1901	21
1902	21
1903	62
Total to date	122

It will be observed that more towns were thus equipped during the past year than during the preceding five years. There seems to be little field for acetylene lighting, however, in cities and towns supplied with ordinary coal or water gas.

A system of storage by absorption has been devised that increases the adaptability of acetylene for lighting cars, boats, etc. Forty steamboats in this country were equipped for acetylene lighting last year. The following railroads, among others, are experimenting extensively with acetylene coach lighting, all having a number of cars equipped with this system.

New York Central and Hudson River.
New York, New Haven and Hartford.
New York and Harlem.
Erie Railroad.
Delaware, Lackawanna and Western.
Chicago, Burlington and Quincy.
Chicago, Rock Island and Pacific.
Atchison, Topeka and Santa Fe.
Delaware and Hudson.
New York, Ontario and Western.

The Delaware, Lackawanna and Western now have 27 cars equipped for acetylene lighting, and are preparing to erect their own charging plant for lighting all of their coaches and stations with acetylene. The New York Central has an entire train lighted with acetylene, and the New York, New Haven and Hartford is now equipping 30 of their cars for acetylene lighting.

SOME ODDS AND ENDS OF THE PAST YEAR.

The Fall River, Mass., and the Charlotte, N. C., gas companies have steam turbine blowers in their water-gas plants.

The Milwaukee Gas Light Company have an emergency stop-box for hollow sidewalks that is giving great satisfaction.

The Pawtucket (R. I.) Gas Company employs a Westinghouse pump for scurfiing retorts.

The Burlington (Vt.) Gas Company uses a Barnum respirator with much satisfaction.

A new form of saw has been put into use during the year for sawing the slots in lava tips, resulting in greater accuracy and smoothness of the slots.

The cloth strainers between the check and the tip of a well-known check burner are now being held in position by steel rings instead of cement.

The American Radiator Company of Chicago are making steam and hot water house-heating boilers especially adapted for the use of gas coke.

Oval-way gas cocks are now being manufactured.

Cast-iron pipes are now being so made as to fit a well-known make of pipe couplings.

A well-known gas main stopper has been improved by the use of a more perfect spring.

One large gas company is discussing the advisability of purchasing coal lands for its own supply of gas coal.

Coal gas is being used for lighting the coaches of the Western Railway of France.

A machine has been brought out that very quickly removes broken taps.

A British patent has been granted for a turbine to be operated by the exhaust from an internal combustion engine.

A patent has been applied for in this country on a pneumatic device for firing bench furnaces with pulverized coal or coke.

A service-pipe thawing machine has been recently patented and put into use.

A device has been developed and successfully tried on a working scale for automatically weighing coal charges into inclined retorts instead of measuring them.

Gas engines operating pumps are now used at the Philadelphia times of fires.

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Davis & Farnum Mfg. Co.,
Connelly Iron Sponge and Governor Co.,
Geo. Shepard Pages' Sons,
The Jeffrey Mfg. Co.,
The Gas Engine Publishing Co.,
Abendroth Brothers,
Albany Foundry Co.,
The Union Stove Works,
F. & L. Kahn & Bros.,
Nathaniel Tufts Meter Co.,
Wm. M. Crane Co.,
Keystone Meter Co.,
Metric Metal Works,

D. McDonald & Co.,
Helme & McIlhenny,
Maryland Meter Co.,
Reeves Prepayment Meter Co.,
Warren Brothers Co.,
Semet-Solvay Co.,
The Bristol Co.,
Michigan Ammonia Works,
Gas Machinery Co.,
The Chaplain-Fulton Mfg. Co.,
The Connersville Blower Co.,
P. H. & F. M. Roots Co.,
The Green Fuel Economizer Co.,
Safety Gas Main Stopper Co.,
H. Mueller Mfg. Co.,
Jacobson Machine Mfg. Co.,
Gas Tip and Self-Lighter Co.,
B. C. Cobb,
Journal of Gas Lighting,
The United Coke and Gas Co.,
C. W. Hunt Co.,
Western Gas Construction Co.,
Bartlett, Hayward & Co.,
United Telpherage Co.,
United Gas Improvement Co.,
Humphrey & Glasgow,
Missouri Fire Brick Co.,
R. D. Wood & Co.,
Parker-Russell Mining and Mfg. Co.,
Laclede Fire Brick Mfg. Co.,
Adam Weber Sons,
Henry Maurer & Son,
J. H. Gautier & Co.,
Power and Mining Machinery Co.,
Allis-Chalmers Co.,
The New Era Gas Engine Co.,
The Westinghouse Machine Co.,
Columbus Machine Co.,

besides many gas companies throughout the United States.

At the conclusion of the reading of the Progress Department Report, the editor was greeted by round after round of applause.

PRESIDENT McILHENNY:—Mr. Butterworth has certainly given us a most admirable presentation of progress in the gas business. We would be glad to have comments or inquiries. It is so thorough and comprehensive, however, that it really leaves nothing else to be said.

MR. BUTTERWORTH:—Mr. President, with your permission, I would like to read a letter I received just before leaving Detroit, referring to gas engines, if I may, and let it become a portion of our proceedings. It is from a manufacturer of large gas engines, referred to in my report, and is as follows:

GAS ENGINE PROGRESS.

"The past year has been remarkable in that it witnessed the greatest interest that ever has been manifested concerning internal combustion engines. Engineers from one end of the country to the other have communicated with us concerning gas engines in very large units for power stations, and we feel that the consensus of opinion among experts to-day is that the large unit gas engine is at last an assured fact. We, ourselves, have not done very much in actual gas engine construction during the past year, but we might say that the greatest progress which we have made in the development of the gas engine and its details has been made during the past year. In this time we have completed the two 4,500 horse-power gas engines which we had under construction, and the erection in the plant in which they are to operate in West Virginia is now so well advanced that we expect both of these engines to be in service within the next four weeks. These two engines are the largest in the world by a very large margin, the largest that we know of outside of these being 2,500 horse-power, so that these two engines of ours are almost twice as big as anything yet built, under construction, or contemplated.

"We are at the present time building four 1,000 horse-power machines of this same type, which are to be in service this coming summer.

"During the past year our company have felt so well satisfied with the development of the gas engine, as carried on by us, that they have decided to go very extensively into the building of gas engines for all purposes, but for large units only, since we do not care to manufacture small units which are now built under very heavy competition.

"We have demonstrated during the past year the ability of gas engines in large units to convert into delivered work from 30 to 40 per cent. of the heat energy contained in the gas consumed. This represents an efficiency two to three times as good as the very highest grade steam engines in the country, and certainly promises much for the gas engine as the prime mover of the twentieth century.

"Five years ago we appreciated the fact that the steam engine had reached its highest state of economical development, and that some other prime motor would surely supersede it in the twentieth century. We investigated the matter carefully at that time and made up our minds that the only prime motor which could do it would be the internal combustion engine, and we accordingly made arrangements to manufacture a number of these under the Klein patents with a view of getting sufficient information to enable us to start on the development of the gas engine along American power-engine lines instead of along foreign lines, as is being done by others. We have been very successful in this, and very shortly we will bring out a line of gas engines strictly American, moulded after American power engines, which development has been a steady, healthy growth during the nineteenth century, and cannot well be set aside or overlooked when considering a prime motor of the future.

"There is no proposition in connection with gas engines in large units which has not been satisfactorily solved, and the next two years we believe that a large number of very large engines driving alternators direct connected will be installed."

MR. STONE:—This report shows the immense amount of work which Mr. Butterworth has done in collecting the facts therein set forth. It is so comprehensive, however, that we will all have to take it home and study it in order to fully appreciate its scope and merit. I therefore move that a hearty vote of thanks be extended to Mr. Butterworth for his most excellent report.

The above motion was then duly seconded and unanimously carried.

PRESIDENT MCILHENNY:—Before we adjourn we will call on F. W. Stone to outline his work in connection with the Bureau of Forms and Records.

Mr. Stone then submitted verbally the following:

REPORT OF BUREAU OF FORMS AND RECORDS.

To the Ohio Gas Light Association:

GENTLEMEN:—It has been suggested if the various gas companies were to see how each of the others kept their accounts and their methods of doing business and the various forms used it would be of great help in formulating some uniform method of keeping accounts. That is, we would get closer together by the use of some one uniform method of keeping our accounts than we could in any other way. We look over some other man's way of doing the work and we might think his way was a good one and adopt the best part of his method, trying to adapt it to our particular way of doing business. Feeling that this would be a benefit to all of the members of the Association, I was asked to take up the work of collecting samples of the different forms and different records used by the various gas companies in keeping their accounts. I wrote to a number of the companies and I got a response, I think, from about 60 of them. Some of them sent me samples of all the forms that they use; others sent samples of what they considered the best, and there has been some work expended in connection with the classification and indexing of these various forms. I had only a short time to do it in. The work has not been altogether satisfactory to me and it is not as complete as I would like to have it. The forms I have collected will be found in the books exhibited. If any one is interested in getting out a new consumers' register, they can find samples from other companies in these books. Or, if you want a new meter log book, or, if you want to know how other companies keep track of labor account, or the form that is used for the contract for fuel-gas appliance, or anything of that kind, we have samples of all of that work here. We have at least one sample, I think, of almost any form that a gas company would require. I do not imagine the record is in any way complete, but it is as complete as I have been able to make it in the time I had to devote to it. I would suggest that the work be kept up, because each one of us, I think, can improve on what we now have. Each one of us can get up a better form next year than this year, and each one of us will, perhaps, make some change in our method of book-keeping. I therefore suggest that the work be continued, and that all of the members furnish the bureau as much information as they can. Forty, or fifty, or sixty gas companies do not represent, by any means, the number of gas companies having officers connected with this Association. If every one were to respond it would help us a great deal. You may think that you have some forms peculiar to some special purpose, or some special condition peculiar to your own company, and you may think that nobody else would be interested in it. Yet, somebody else might be doing business under just exactly the same conditions, and we want the forms you are using and which would enable him to keep his accounts under just the same conditions you are keeping yours, and he would be glad to look over what you have, even though he might not adopt the method employed by you. It would give him an idea, perhaps, how he could change or modify the forms submitted to suit his own peculiar condition. I believe that is all I have to say, Mr. President. The books are here. If any one wants to look at them they are at liberty to do so. If you want to look up some particular department you will find an index in the front of each one of the books and the different forms used in that department are classified so that you can find them without much difficulty, I trust. I tried to arrange them, at any rate, so that you would have no difficulty in finding just what you wanted.

Respectfully submitted, F. W. STONE.

President McIlhenny:—Mr. Stone has certainly done a great deal of work in collecting these forms and records, and any member wishing to avail himself of the forms and records submitted can do so. They will be here upon the platform, accessible to all members throughout the rest of the meetings. I do not know what provision has been made for furnishing information during the year, but I should imagine if any of the members at any time during the year, after this meeting has adjourned, desired information as to particular forms and records, by writing to Mr. Stone he could furnish them with sample slips which could be returned, or, even the whole book could be furnished, the understanding being that it would be returned as promptly as possible.

Mr. Stone:—Mr. President, I think I have indicated on each one of the forms, or each one of the leaves in the different books, the gas company the particular form came from, and I suggest in looking over the forms if you see something which you think is good and you want to talk to the representative of the gas company about it, you can look him up and ask him how he likes it, or how it works, and all that sort of thing. In that way, perhaps, you will get better acquainted with the forms and the way in which they are used than by asking me to furnish the information. If I possessed the information I would be only too glad to furnish it, but many of these forms have simply been submitted to me to form a part of the collection, and I know but little, personally, about the workings of the various forms sent in. I might not be able to explain how the particular gas company keeps a particular account, with which I am not familiar, and it would be much better for any one desiring such information to see the representative of the gas company furnishing the form and getting the information in that way. I would, of course, be glad to help all that I can.

It was then moved, seconded and carried, that a vote of thanks be extended to Mr. Stone for the work expended and the results submitted on behalf of the Bureau of Forms and Records.

President McIlhenny:—The Association thanks Mr. Stone for his untiring work in the matter. We will not take up any further papers this afternoon. To-night there will be a smoker held in this room at 8:30, a courtesy extended to the members by the local Committee on Entertainment. As the members go out from the hall this afternoon they will find theater tickets outside the door for to-morrow evening, which are also furnished through the courtesy of the local Entertainment Committee.

On motion, duly seconded and carried, the meeting then adjourned until Thursday, March 17, 1904, at 9:30 A. M.

SECOND DAY—MORNING SESSION.

The Association met at 9:30 A. M. President McIlhenny commenced the proceedings by calling for the reading of a short topic by Mr. Malone, of Denver, Colo., entitled:

BURNING COKE BREEZE WITH UNDERFEED STOKERS.

M. E. MALONE.

The utilization of coke breeze as fuel is a subject which has been given a great deal of thought, and many experiments have been made to ascertain some practical method by which it can be successfully used for this purpose. It is only within a recent period that any real success has been obtained in using the coke breeze for fuel purposes, but when we consider that all coke delivered to the yard, by the time it is crushed, screened, handled and ready for the market, produces from 10 to 15 per cent. of breeze, which contains from 75 to 80 per cent. of carbon, it is self-evident that we have a valuable fuel residual which has been heretofore regarded as almost useless.

There are two methods employed for burning breeze in furnaces under boilers that have met with more or less success.

First.—Underfeed mechanical stokers.

Second—Forced, or induced draft attachments to furnace, in connection with some form of specially adapted grate bars.

The following report shows results of tests in Denver with each of the above methods:

REPORTS OF TESTS.

Mr. M. E. Malone, Supt. Gas Department:

DEAR SIR:—Some time ago we completed the installation of a simple forced-draft arrangement for the burning of breeze at our West Side Electric Station, as follows:

Selecting two batteries of two 160 h. p. B. & W. boilers per battery, having a three-foot alley way between batteries, which were giving rather poor service, due perhaps to poor draft from short individual stacks per battery, we placed an 18-inch rivited pipe about 6 feet long, closed at one end and open at other end to a No. 9 Sturtevant Blower in said alley parallel to grate bars with center of pipe, some 10 inches below bottom of grate bars and with closed end of pipe just even with end of grate at bridge wall of boiler, thus placing the delivery pipe, so to speak, just opposite the grate bars, but below same. This pipe was furthermore made with six openings, three on a side, provided with nipples, draft grates and lastly with nipples and flanges. We then passed three 5-inch wrought iron pipes capped at one end and directly through the side wall and center wall, equally spaced from bridge wall to dead plate, and allowed capped end to rest in last side wall, the other ends being connected by companion flanges to flanges of nipples at 18-inch pipe as provided; these pipes passing transversely and some 3.5 inches below the grate bars; the same being done for opposite battery, the three 5-inch pipes being fastened to nipples of 18-inch pipe diametrically opposite those of first battery. Thus it will be seen that both batteries or the four boilers were hooked up to one blower and so arranged to run one or both batteries.

The 5-inch blast pipes are perforated with two double rows of 0.56-inch holes, at 2-inch centers and staggered allowing 2.5 inches between sets of rows, holes in sufficient number to equal discharge volume of 5-inch pipe, taking into account friction, contracted orifice, etc. These pipes are so placed that one set, or double row, of holes is turned directly down and the other facing up at an angle of 45 degrees, and seemingly gives a good distribution of air. The blower running at 1,500 r. p. m. is belt-driven from 15 h. p. motor delivering about 0.59-inch water pressure in 18-inch pipe, and when up to speed using a little less than above power for all boilers.

Owing to the present inconvenience and limited time, we have not been able to arrange for an evaporation test with this arrangement, but within a short time will have completed arrangements for accurate tests. Under the circumstances, I attempted an approximate comparison with breeze and Baldwin slack coal as fuel, using the two boilers of one battery, giving us the same draft conditions, etc., as follows:

Filled both boilers with water so as to register 8.5 inches on gauge glasses, marking height on glasses, then closed tightly the supply valve at each boiler. Then fired one boiler with a weighed amount of breeze and fired the other with a weighed amount of Baldwin coal, noting the time at the beginning and end of test, the end of test being taken when water in gauge stood at exact bottom of glass, or when exactly 8.5 inches of water was evaporated, as shown by gauge. The results and data of this test follow:

EVAPORATION TEST WITH COAL AND COKE BREEZE.

	Boiler fired with breeze.	Boiler fired with coal.
Fuel weighed to boiler..................pounds	702.0	691.0
Fuel weighed back at end of test..........pounds	105.0	50.0
Fuel weighed actually burned............pounds	597.0	641.0
Time to evap. 8.5 ins. water on gauge....minutes	40.0	30.0
Amount of fuel burned per minute.......pounds	14.9	21.3
Inches water on gauge evap. per minute..........	0.213	0.283
Inches of water per min. per pound of fuel......	0.0143	0.0132
Gain in favor of breeze ....per cent.	7.6	....
Rate of burning per sq. ft. grate per hr...pounds	29.8	42.6

The rate of combustion gives data which would need more study to give better and more accurate comparisons. The draft at blower —0.59 inches and in stacks about —0.30 inches. The fires needed no cleaning, being free from clinkers, and the air distribution good, no holes in fires.

The second test consisted of timing the evaporation of same amount of water as before by burning a weighed amount of the mixture of breeze and Baldwin coal, in 1 to 1 proportion. The data and results follow:

EVAPORATION TEST WITH COKE BREEZE AND A COAL-COKE MIXTURE.

	Breeze.	Equal parts breeze and coal.
Fuel weighed to boiler ....pounds	702.0	792.0
Fuel weighed back.......................pounds	105.0	85.0
Fuel actually burned ....pounds	797.0	707.0
Time to evap. 8.5 ins. water on gauge....minutes	40.0	40.0
Gain in favor of breeze ....per cent.	12.7	......
Rate of cambustion per square foot, grate per hour	29.8	35.2

Encouraged by these rough tests, and finding that by trial we could burn breeze in the new 500 h. p. Heine boilers, which have an excellent draft, we decided we would attempt holding the steam pressure for our day load at this station with the following success:

We fired with breeze only, the four B. & W. boilers, together with two 200 h. p. Heine boilers fired with lump coal having a third 200 h. p. Heine banked and ready for use. This made a total of some 1,640 rated boiler horse-power fired with coal. Under this arrangement we held the station load, some 3,000 horse-power, until 10:30 A. M., when the load increased somewhat and it was necessary to clean fires, when we found it necessary to mix a little U. P. lignite slack coal with the breeze for an hour or two to increase the capacity evaporation, and then again fired straight breeze as before until evening load came on with a change of firemen, who are not as yet acquainted with the method of handling breeze, so that we fired coal in the large boilers, not using the breeze boilers unless for peak load demands.

To sum up I wish to state that we are at present firing the six boilers with breeze during the day with good success, burning between 18 and 20 tons of same per day. In firing breeze straight we find no clinkers whatever. It needs a little more handling and light firing, while in firing the mixture and particularly when mixed with moist coal, we find considerable clinkering and much more work in handling fires.

In conclusion I wish to state that a similar arrangement of forced-draft is being completed on two 50 h. p. Kewanee tubular boilers at the gas works. When completed this will offer better facilities for accurate evaporation tests than we are at present able to make, and I hope within ten days to be able to present more accurate results and furnish data which will present the breeze proportion further in detail, from which we can then work up or know the commercial value of this seemingly useless product. Therefore kindly consider these results as roughly approximate, but from observations and from what study I have been able so far to give to the subject, as highly encouraging.

Yours very truly,

Denver, Colo., January 29, 1904. H. R. WEBER.

Having completed the forced draft arrangement at Gas Works, I take pleasure in presenting this supplementary report as promised in my communication of January 29, 1904.

The following results are those obtained from evaporative tests made at the Seventh Street Gas Works, using as fuel, breeze and a mixture of one to one of breeze and Northern slack coal, as burned with underfeed stoker and burned under a special forced draft arrangement, giving comparative values of the different fuels, and the capacity and efficiencies of the boilers under the two different boiler equipments as installed at these works:

TESTS OF A 50-HORSE-POWER KEWANEE TUBULAR BOILER.

Dimensions and Proportions:

Grate surface 4 feet 6 inches wide by 5 feet 0 inches long ....sq. ft.	22.5
Water heating surface of shell 48 inches diam., 16 feet long, 48 flues 3 in. diam., 16 ft. 0 in. long......sq. ft.	704.0

Test No. 1—February 8, 1904.

Underfeed stoker burning breeze.

Duration of tests ....hours	5.0
Steam-pressure boiler, average ....lbs.	90.0
Average temp. of feed water entering injector......deg.	56.0
Average temp. of feed water leaving injector......deg.	152.0
Average temperature of chimney gases............deg.	500.0
Force draft at delivery pipe of stoker...........inches	3.5
Force of draft in throat of boiler...............inches	30.0

Evaporation.

Water evaporated ....lbs.	7,004.0
Water evaporated corrected for injector...........lbs.	7,634.4
"Breeze" burned, as fired.........................lbs.	1,319.0
Ashes and clinkers ....lbs.	310.0
Refuse to "breeze" ....per cent.	23.5
Water evaporated to 1 lb. breeze, actual............lbs.	5.77
Equiv. evap. from and at 212 deg. to 1 lb. breeze	6.31
Equiv. evap. from and at 212 deg. to 1 lb. comb.........	8.26
Breeze burned per stoker ....per hour	263.8
Water evaporated per sq. ft. heating surface per hour..lbs.	2.16
Horse-power developed	48.4
Rated horse-power	50.0
Below rating ....per cent.	3.2

Efficiency.

Calorific value of dry breeze per lb. by Parr Cal..B. T. U.	10,658.0
Calorific value of combustible per lb. by Parr Cal..B. T. U.	13,045.0
Efficiency of boiler (based on combustible)....per cent.	61.0
Efficiency of boiler including grate, etc., based on dry breeze) ....per cent.	57.0
Horse-power by engine running stoker........per hour	2.0
H. P. by motor running blast for stoker........per hour	1.5
Power used by motor and stoker..............per cent.	7.2

Analyses.

Breeze.	Moisture	per cent.	2.3
	Carbon	per cent.	77.6
	Ash	per cent.	20.1
Flue Gas.	CO_2	per cent.	4.2
	O	per cent.	16.6
	CO	per cent.	....

Test No. 2—February 9, 1904.

Underfeed Stoker, Burning Breeze.

Duration of tests	hours	5.0
Steam pressure boiler, average	lbs.	88.0
Average temp. of feed water entering injector	deg.	57.0
Average temp. of feed water leaving injector	deg.	154.0
Average temperaure of chimney gases	deg.	500.0
Force of draft in breeching	inches	0.30

Evaporation.

Water evaporated	lbs.	5,189.0
Water evaporated, corrected for injector	lbs.	5,656.0
Breeze as fired	lbs.	1,030.0
Ashes and clinkers	lbs.	238.0
Refuse to breeze	per cent.	23.1
Water evap. to 1 lb. breeze, actual	lbs.	5.49
Equiv. evap. from and at 212 deg. to 1 lb. breeze	lb.	6.01
Equiv. evap. from and at 212 deg. to 1 lb. comb	lb.	7.82
Breeze burned per stoker per hour	lb.	206.0
Water evap. per sq. ft. heating surf, per hour	lb.	1.6
Horse-power developed		35.9
Refuse to breeze	per cent.	23.1

Efficiencies.

Efficiency of boiler (based on combustible)		57.0
Efficiency of boiler, including grate, etc., (based on dry breeze)		54.0
Power used by motor and stoker	per cent.	10.0

Flue Gas Analysis.

CO_2	per cent.	5.6
O	per cent.	15.1
CO	per cent.	None
CO_2	per cent.	7.2
O	per cent.	13.6
CO	per cent.	None

Test No. 3—February 18, 1904.

Underfeed Stoker, Burning Breeze and Coal, 1 to 1.

Duration of test	hours	4.0
Steam pressure boiler, average	lbs.	88.0
Average temp. of feed water entering injector	Fah. deg.	57.0
Average temp. of feed water leaving injector	Fah. deg.	153.0
Average. temp. of chimney gases	Fah. deg.	550.0
Force of draft in breeching	inches	0.30

Evaporation.

Water Evaporated	lbs.	8,823.0
Water evap., corrected for injector	lbs.	9,617.0
Fuel as fired	lbs.	1,684.0
Refuse—clinkers, 191; ashes, 53	lbs.	244.0
Refuse to fuel	per cent.	17.5
Water evap. to 1 lb. of fuel, actual	lbs.	5.71
Equiv. of water evap. from and at 212 degrees to 1 lb. fuel		6.27
Equiv. of water evap. from and at 212 degrees to 1 lb. comb.		7.33
Fuel burned per stoker	per hour	421.0
Pounds of water evap. per sq. ft. heating surface, per hour		3.41
Horse-power developed		76.0
Increase over rating	per cent.	52.0

Efficiencies.

Efficiency of boiler (based on combustible)		64.0
Eff. of boiler inc. grate, etc., (based on fuel)		58.0
Power used by motor and stoker	per cent.	4.6

Analyses.

Flue Gas.	CO_2	per cent.	5.2	7.1
	O	per cent.	15.2	13.3
	CO	per cent.	none	none
Ash—Unburned carbon		per cent.		26.6
	Ash	per cent.		73.4

Test No. 4—February 16, 1904.

Flat Grates, With Small Draft Tubes Out, Giving Ash Pit Draft, Burning Breeze.

Duration of test	hours	4.0
Steam pressure boiler, average	lbs.	91.0
Av. temp. of feed water entering injector	deg. F.	57.0
Av. temp. of feed water leaving injector	deg. F.	154.0
Av. temp. of chimney gases	deg. F.	380.0
Force of draft at bridge wall	inches	3.0
Force of draft in breeching	inches	0.25

Evaporation.

Pounds of water evaporated		4.521.0
Pounds of water evap. corrected for injector		4,928.0
Pounds of "breeze" as fired		1,000.0
Pounds of refuse—clinkers, 95; ashes, 260		355.0
Per cent. of refuse to "breeze"		35.0
Pounds of water evap. to 1 lb. breeze, actual		4.92
Equiv. water evap. from and at 212 deg. F. to 1 lb. breeze	lbs.	5.39
Equiv. water evap. from and at 212 deg. F. to 1 lb. comb.	lbs.	8.37
Breeze burned per hour	lbs.	250.0
Breeze burned per sq. ft. grate surface per hr	lb.	11.1
Pounds water evap. per sq. ft. heating surface	per hour	1.75
Horse-power developed		39.1
Below rating	per cent.	21.8

Efficiencies.

Calorific value of breeze per lb	B. T. U.	10,658.0
Calorific value of combustible	B. T. U.	13,045.0
Eff. of boiler (based on combustible)		62.0
Eff. of boiler including grate (based on breeze)		48.0
Horse-power per hour motor running blast		1.25
Per cent. of power used by motor		3.2

Analyses.

Flue Gas.	CO_2	per cent.	5.8	3.4
	O	per cent.	14.7	17.4
	CO	per cent.	none	none

Test No. 5—February 17, 1904.

Flat Grates, With Draft Tubes in, Holes Turned Up, Slots in Pipes Turned Down, Burning Breeze.

Duration of test	hours	3.0
Steam pressure boiler average	lbs.	92.0
Average temp. of feed water to boiler	deg. F.	156.0
Average temp. of chimney gases	deg. F.	420.0
Force of draft at bridge wall	inches	3.5
Force of draft in breeching	inches	0.30

Evaporation.

Pounds of water evaporated		3,939.0
Pounds of water evap. corrected for injector		4,294.0
Pounds of "breeze" as fired		1,000.0
Pounds of refuse—clinkers, 88; ashes, 225		313.0
Per cent. of refuse to breeze		31.0
Pounds of water evap. to 1 lb. breeze, actual		4.29
Equiv. water evap. from and at 212 deg. F. to 1 lb. breeze	lbs.	4.70
Equiv. water evap. from and at 212 deg. F. to 1 lb. comb.	lbs.	6.86
Pounds of breeze burned per hour		333.0
Pounds breeze burned per sq. ft. grate surface, per hour		14.3
Pounds water evap. per sq. ft. heating surface, per hour		2.03
Horse-power developed		45.5
Below rating, per cent		9.0

Efficiencies.

Eff. of boiler (based on combustible)	50.0
Eff. of boiler inc. grate (based on breeze)	42.0
Per cent. of power used for motor	3.2

Analyses.

Flue Gas.	CO_2	per cent.	3.4
	O	per cent.	17.0
	CO	per cent.	none
Ash—	Unburned carbon	per cent.	34.4
	Ash	per cent.	65.6

Test No. 6—February 17, 1904.

Flat Grade, Forced Draft Arrangement Complete, Burning Mixture of Breeze and Northern Slack Coal, 1 to 1.

Duration of test	hours	3.0
Steam pressure boiler, average	pounds	90.0
Average temp. of boiler feed water	deg. F.	156.0
Average temp. of chimney gas	deg. F.	450.0
Force of draft	inches	0.30

Evaporation.

Pounds of water evaporated		5,295.0
Pounds of water evap. corrected for injector		5,772.0
Pounds of fuel as fired		1,100.0
Pounds of refuse—clinkers, 50; ash, 113		163.0
Per cent. of refuse to fuel		14.8
Pounds of water evap. to 1 lb. fuel, actual		5.24
Equiv. water evap. from and at 212 deg. F. to 1 lb. fuel	lbs.	5.74
Equiv. water evap. from and at 212 deg. F. to 1 lb. comb.	lbs.	7.55
Fuel burned per hour	lbs.	366.0
Fuel burner per hour per sq. ft. grate surface	lbs.	16.2
Pounds of water evap. per hr. per sq. ft. heating surface		2.73
Horse-power developed		61.0
Above rating	per cent.	22.0

Efficiencies.

Eff. of boiler (based on combustible)	61.0
Eff. of boiler inc. grate (based on fuel)	53.0
Per cent. of power used by motor for blast	3.2

Analyses.

Flue Gas.	CO_2	per cent.	6.0
	O	per cent.	14.1
	CO	per cent.	none
Refuse.	Unburned carbon	per cent.	47.8
	Ash	per cent.	52.2

Test No. 7—February 18, 1904.

Flat Grates, Forced Draft Arrangement, Burning Northern Lignite Slack Coal.

Duration of test	hours	2.0
Steam pressure boiler, average	pounds	91.0
Average temp. of feed water		156.0
Average temp. of chimney gases		480.0
Force of draft	inches	0.30

Evaporation.

Pounds of water evaporated	4,397.0
Pounds of water evap. corrected for injector	4,793.0
Pounds of coal as fired	900.0
Pounds of refuse	65.0
Per cent. of refuse to coal	7.2

Pounds of water evap. to 1 lb. coal, actual	5.32
Equiv. water evap. from and at 212 deg. F. to 1 lb. coal	5.83
Equiv. water evap. from and at 212 deg. F. to 1 lb. comb. lbs.	6.29
Fuel burned lbs. per hour	450.0
Fuel burned per hr. per sq. ft. of grate surface lbs.	20.0
Water evap. per hr. per sq. ft. of heating surface	3.2
Horse-power developed	76.0
Above rating per cent.	52.0

Efficiencies.

Calorific value of coal per lb.	10,174.0
Calorific value of combustible per lb.	10,746.0
Eff. of boiler (based on combustible)	56.5
Eff. of boiler inc. grate, etc. (based on coal)	55.3
Per cent. of power for motor driving blast	3.2

Analyses.

Coal—Moisture	per cent.	12.01
Volatile	per cent.	35.19
Carbon	per cent.	46.24
Ash	per cent.	6.56
Flue Gas. CO_2	per cent.	4.0
O	per cent.	16.5
CO	per cent.	none

TEST OF A 500-HORSE-POWER HEINE BOILER.

Test No. 8—February 6, 1904.

West Side Electric Station, Natural Induced Draft, Burning Breeze.

Duration of test hours	2.0
Absolute steam pressure	137.0
Average temperature of feed water	193.0
Average temperature of chimney gases	413.0
Force of draft	0.65

Evaporation.

Pounds of water evaporated	15,803.0
Pounds of "breeze" fired	3,500.0
Pounds of refuse	......
Per cent. of refuse to breeze	......
Pounds of water evap. to 1 lb. breeze, actual	4.50
Equiv. evap. from and at 212 deg. to 1 lb. breeze	4.78
Equiv. evap. from and at 212 deg. to 1 lb. comb.	......
Breeze burned per hour	1,750.0
Breeze burned per hr. per sq. ft. grate surface	24.8
Water evap. per hr. sq. ft. heating surface	1.77
Horse-power developed	302.0
Per cent. below rating	39.0

Efficiencies.

Efficiency of boiler (based on combustible)	......
Efficiency of boiler including grate (based on breeze)	43.5

	1	2.	3.	4.	5.	6.	7.	8.
Steam pressure, boiler gage, pounds	90.0	88.0	88.0	91.0	92.0	90.0	91.0	137.0
Force of draft in stack, inches	0.30	0.30	0.30	0.25	0.30	0.30	0.30	0.65
Water evap. per hour, pounds	1,527	1,131	2,404	1,232	1,431	1,924	2,396	7,901
Fuel burned per hour, pounds	264	206	421	250	333	366	450	1,750
Per cent. refuse	23.5	23.1	17.5	35.0	31.0	14.8	7.2	.....
Water evap. per pound fuel, actual pounds	5.77	5.49	5.71	4.92	4.29	5.24	5.32	4.50
Equiv. evap. from 212 deg. per pound, fuel pounds	6.31	6.01	6.27	5.39	4.70	5.74	5.83	4.78
Equiv. evap. from 212 deg. per pound, comb. pounds	8.26	7.82	7.33	8.37	6.86	7.55	6.29	.....
Builders rated H. P., per cent	50.0	50.0	50.0	50.0	50.0	50.0	50.0	500.0
Horse-power developed, per cent	48.5	35.9	76.0	39.0	45.5	61.0	76.0	302.0
Per cent. of rated H. P., developed, per cent	97.0	72.0	152.0	78.0	91.0	120.0	132.0	60.0
Fuel burned per sq. ft. grate surface, per hour, pounds	....	....	....	11.1	14.3	16.2	20.0	24.8
Water evap. per sq. ft. heating surface, per hour, pounds	2.16	1.6	3.41	1.75	2.03	2.73	3.2	1.77
Efficiency of boiler (based on comb.) per cent	61.0	57.0	64.0	62.0	50.0	61.0	56.0	.....
Efficiency of boiler and grate (based on fuel)	57.0	54.0	58.0	48.0	42.0	53.0	55.0	43.5
Per cent. of power used by installation	7.2	10.0	4.6	3.2	3.2	3.2	....	....
Cost of Evaporation:								
Cost of fuel per ton of 2,000 pounds in boiler room	2.31	2.42	2.33	2.68	2.98	2.54	2.50	2.88
Cost of power for evap. 1,000 pounds water, under observed conditions	0.073	0.0985	0.0461	0.0461	0.0389	0.0288	0.0232	.....
Cost of fuel for evap. 1,000 pounds water under observed conditions	2.201	0.220	0.203	0.272	0.347	0.241	0.235	0.319
Cost of power and fuel for evap. 1,000 pounds water from and at 212 deg	0.254	0.297	0.230	2.292	0.353	0.248	0.236	0.300
Cost of power and fuel for evap. 1,000 pounds water from and at 212 deg. and cost of maintenance	0.274	0.325	0.243	0.295	0.355	0.250	0.237	.....
Cost of apparatus and installation		$700.00				$275.00		
Cost of maintenance repairs per year		200.00				10.00		
Depreciation, 10 per cent. per year		70.00				27.50		

Analyses.

Flue Gas.	CO_2, 6.2 per cent.; O, 12.6 per cent.; CO....		None
Breeze.	Moisture	per cent.	4.6
	Carbon	per cent.	68.2
	Ash	per cent.	27.2
	Calorific value Parr calorimeter	B.T.U., per lb.	10,658.0
Clinker.	Unburned carbon	per cent.	31.8
	Ash	per cent.	68.2
	Total carbon wasted	per cent.	8.64
	Total breeze wasted	per cent.	5.89
Ash.	Uuburned carbon	per cent.	27.0
	Ash	per cent.	73.0
	Total carbon wasted	per cent.	7.34
	Total breeze wasted	per cent.	5.0

TABULAR COMPARATIVE SUMMARY.

Column I.—Burning Breeze on underfeed stoker.

Column II.—Burning Breeze on underfeed stoker, second test made while adjoining boiler in battery was cold.

Column III.—Burning mixture of breeze and slack coal on stoker.

Column IV.—Burning breeze on Sheffield flat grates, hand-firing under forced draft, admitting air to closed ash-pit through pipe in bridge wall only.

Column V.—Burning breeze on Sheffield flat grates, hand-firing under special forced draft arrangement complete, with draft tubes under grates, holes in said tubes turned up.

Column VI.—Burning mixture of breeze and coal on Sheffield flat grates, hand-firing under forced draft, as in No. 5.

Column No. VII.—Burning lignite slack coal on Sheffield flat grates, as in No. 6.

Column VIII.—Burning breeze on Sheffield grates, with ¼-inch mesh, hand-firing, under natural induced draft.

Yours very truly,

Denver Colo., February 20, 1904. H. R. WEBER.

PRESIDENT McILHENNY:—This is a very interesting paper with reference to the utilization of a waste product at least in some of the gas plants. It is now open for discussion. Any comments or questions to be asked, Mr. Malone?

MR. MALONE:—I understand that the paper of Mr. C. H. Williams is on practically the same general subject, and I would suggest that it might be a good idea to have both papers read at this time so that they will each be before the meeting for discussion.

President McIlhenny:—Mr. Williams, I believe, is not present this morning, and I will therefore call on Mr. H. L. Olds, Lincoln, Ill., to read the paper of Mr. Williams on the subject.

BURNING COKE BREEZE ON HOLLOW GRATES.

C. H. WILLIAMS.

The following test, carried out at the gas plant of the Madison Gas and Electric Company, was made to determine the value of coke breeze as boiler fuel.

The boiler on which the test was made was an 18′ x 72″ horizontal cylindrical tubular, fitted with a patent gate bar made especially for handling coke breeze.

The fuel is hand fired, and a forced draft is furnished by a No. 5 Sturtevant volume blower, which has the following capacity:

Air pressure at fan outlet.	Speed, r. p. m.	Volume of air.
¾ ounce	878	1,490 cubic feet.
1 "	1,015	1,725 " "
1½ "	1,240	2,110 " "
2 "	1,440	2,450 " "

The blower delivers its air to a system of hollow grate bars, from which it is fed under the fuel bed at a practically uniform rate.

The run was made under ordinary running conditions, and no effort was made to obtain any different results than those obtained in our every day practice. The fuel was carefully weighed in iron barrows as it was brought into the firing floor and the ashes weighed back. The water was weighed by means of a system of two tanks on scales, which emptied into a third, from which the feed pump suction was taken, and at the same time a check was made upon the hot-water meter which is used to check the daily results obtained.

The coke breeze was then taken from the crusher as it was working on coke which had been taken from the top of the coke pile, and was a fair sample of the breeze ordinarily obtained.

A cubic foot of this breeze was placed in a box and weighed, after having carefully weighed the box. The box and contents were then placed on top of the water-gas generating apparatus in a good, hot place and allowed to stand for ten days, when the box and contents were again carefully weighed. It was found that the weight of the breeze alone had shrunk 15 per cent., due to contained water being evaporated. Frequent weighing was made during the ten days, and at the end of the period the weight had become practically constant, as most of the free water had been driven off.

The usual precautions as to conditions of fire, height of water at the beginning and ending of the test, were made and recorded, and proper corrections made where necessary.

The samples of flue gases were taken at the bottom of the stack and about two feet above the top of the boiler setting, a long water jacketed collecting tube reaching to the center of the stack being used to take the samples, which were siphoned out by water in the collecting tube and sampling cans.

The samples of flue gas showed great over-ventilation of the furnace, too much air being sent through the fuel bed by the blower.

LOG OF BOILER TEST AT THE GAS WORKS OF THE MADISON GAS AND ELECTRIC COMPANY, JANUARY 19, 1904.

Length of Test, 13 Hours.

Dimensions:		
Water heating surface	sq. ft.	1,670
Grate surface	sq. ft.	30
Ratio of heating to grate surface		55.6
Pressures:		
Steam gage	lbs.	81.6
Steam gage absolute	lbs.	96.3
Steam pressure (calorimeter, absolute)	lbs.	14.75
Temperatures:		
Escaping gases (from pyrometer)	deg. Fahr.	524.3
Feed water from lake	deg. Fahr.	37
Feed water entering boiler	deg. Fahr.	111.88
Fuel:		
Total breeze (including 15 per cent. moisture)	lbs.	9,153
Dry breeze	lbs.	7,795
Total refuse	lbs.	2,660
Total combustible	lbs.	5,135

Average Combustion Per Hour:		
Total coke breeze	lbs.	750
Total breeze (dry)	lbs.	611.5
Total combustible	lbs.	394
Total combustible per sq. ft. grate surface	lbs.	13.1
Total dry breeze per sq. ft. grate surface	lbs.	20.38
Total dry breeze per sq. ft. heating surface	lbs.	0.466
Total combustible per sq. ft. heating surface	lbs.	0.307
Flue Gases:		
CO_2	per cent.	6.1
CO	per cent.	0.3
O	per cent.	12.4
Quality of steam	per cent.	98.3
Total Water:		
Total pumped	lbs.	40,257
Total evaporated	lbs.	39,600
Factor of evaporation		1.1417
Equivalent from and at 212 degrees	lbs.	45,200
Water—Average Per Hour:		
Pumped	lbs.	3,100
Evaporated, dry steam	lbs.	3,040
Equivalent from and at 212 degrees	lbs.	3,480
Economic Evaporation:		
Per lb. fuel	lbs.	4.33
Per lb. dry breeze	lbs.	4.975
Per lb. combustible	lbs.	7.73
Equivalent from and at 212 deg. (fuel)	lbs.	4.94
Equivalent from and at 212 deg. (dry breeze)		5.69
Equivalent from and at 212 deg. (combustible)		8.84
Evaporation Per Hour:		
Per sq. ft. grate surface, from feed water temperature	lbs.	101.7
Per sq. ft. grate surface, equivalent at 212 deg.	lbs.	116
Per sq. ft. heating surface, actual	lbs.	1.82
Per sq. ft. heating surface at 212 deg.	lbs.	2.08
Horse Power.—On a basis of 34.5 lbs. equivalent evaporation per horse-power per boiler:		
Horse-power		101
Efficiency of Boiler:		
B. T. U. utilized per lb. combustible B. T. U. total per lb. combustible		60.5%
Power to operate blower in kw.-hours		104.5

It was then moved, seconded and carried that Mr. Malone and Mr. Williams each be extended a vote of thanks by the Association for the very excellent contributions prepared by them.

PRESIDENT McILHENNY:—The next paper before us is, "Construction and Operation of Recuperative Benches, No. II," by W. A. Baehr, of St. Louis, Mo. This is a paper following the one

EUGENE PRINTZ—1888. EDWARD LINDSLEY—1890.

ANDREW HICKENLOOPER—1884–1886.

CHARLES R. FABEN, JR.—1891. H. WILKIEMYER—1892.

prepared and published in our last year's proceedings. Mr. Baehr is unable to be present with us to-day, although we expected him here. I will ask Mr. Doty to be kind enough to read it for him.

MR. PAUL DOTY, Denver, Colo.:—Mr. President, it is understood, of course, if I read this paper, that I am simply saving the Secretary's voice.

THE CONSTRUCTION AND OPERATION OF RECUPERATIVE BENCHES. II.

W. A. BAEHR.

When I wrote my paper on the same subject as above for the meeting of the Ohio Gas Light Association during March, 1903, it was with the intention of continuing the same line of reasoning followed in that paper, only extending the same to finer scientific methods for the discussion I intended to present this year. Unforfortunately for that intention, I was transferred to St. Louis soon after the March meeting, 1903, and the duties of my position have taken up so much of my spare time, that until very recently I was forced to suspend those interesting heat studies to which my previous paper serves as an introduction.

The short interval from the time of the resumption of those studies until now has been too limited to work out such a paper as I desire to present, and therefore I will confine this discussion to a few of the practical and important considerations of the materials of bench construction. I will add that it was only the most earnest solicitation of our Secretary, Mr. Jones, that caused me to consent to write my views this year. It is my intention to present certain lines of reasoning regarding the quality of fire clay products used in bench construction in as forceful a manner as possible, simply because it seems we are away behind the times on this subject. We are using all kinds of these products in enormous quantities every year, and most of these goods are of such inferior quality that we, as gas men, ought to be ashamed that we permit such construction.

Quality.—Among the rare but shining examples of good bench construction we can point to the new retort houses in Milwaukee and Lowell, and for linings for water-gas sets of unusual excellence Chicago would surprise all except those acquainted with the gas company's plants in that city. Now I am referring to the workmanship and to the quality of the fire-clay products at these places, and not to points relating to design, and I think the engineers who are responsible for these excellent structures deserve the highest praise. The whole matter was most forcibly brought to my attention last fall. We installed a number of large water-gas sets, and it is certainly rather disgraceful to be obliged to record that the linings of all of them will have to be renewed this spring. Six months' life for a carburetter lining is indeed a poor showing.

As is well known, St. Louis has some of the largest and most important fire brick manufactories in the United States, and its clays are said to be equal to any in the world for this purpose. In order to get at the matter in a comparative way I procured samples of tile made in Stettin, Germany, from Mr. West in England, and from all the St. Louis manufacturers. Thereupon the matter was taken up with all the local firms in this line and the result will be, of course, that we will secure vastly better material.

I wish to state right here that there is absolutely no desire on my part to injure a manufacturer, or to advertise another, but these remarks simply emanate from a strong desire to see the gas engineering profession lifted to a higher plane of scientific principles. What gas engineer can witness the progress in modern machine tools, in electrical engineering, in gas engine engineering, in any branch of science, without being filled with the hope of similar advancements in his own line? Progress, and rapid progress at that, is the spirit of the time, and those who fall behind imperil their own interests.

Requirements.—In justice to the manufacturers I will state that after an interview with them, the impression prevails that the gas companies are themselves largely to blame for the present state of affairs. Bids for retorts, benches and shell linings have been requested, and the lowest bidder, generally, irrespective of quality of goods, received the order. This, of course, led to keen competition, low prices, and the inevitable deterioration of quality. This is all wrong. To secure quality we must pay a sufficient price, and it is right to give the order to the lowest bidder *only when his goods are strictly up to specifications and requirements.* For instance, who would buy a modern lathe, electric transformer, watch or any machine simply because it was the cheapest offered?

The requirements to be filled by fire-clay products for gas manufacture are as follows:

First.—The material must be capable of withstanding the highest heats which can be employed in gas making without melting down. There is no question but that all gas-making processes should be run at the highest heats, and therefore this requirement is imperative.

Second.—The material must be such as to be able to readily withstand transportation and handling.

Third.—The material must have great resistivity against mechanical action, such as the friction of rakes, pokers, etc.

Fourth.—The material must have a co-efficient of expansion that is practically nil.

Fifth.—The material must have a structure as nearly as possible *perfectly indifferent* to frequent and extensive changes of temperature.

Sixth.—The material must not readily fuse with clinkers in the fire beds.

Seventh.—The material must present the proper physical characteristics of strength, smoothness, hardness and fineness.

Eighth.—The material must be furnished practically exact as to size.

Composition.—In conversation with a number of manufacturers I have been informed that the chemical composition is not so important as one would at first suppose. They say that one clay from one part of the country would serve a certain purpose very nicely, wheras a clay of the same composition from another part might fail entirely. This may have been the case, but the fact remains, chemical composition is very important. An instance was cited where a Pittsburgh glass company imported a German fire-clay man of great repute abroad, but who failed utterly to secure results with American clays, although he used chemical compositions similar to those obtaining in Europe.

It is, of course, pre-eminently true that the physical treatment of the clays, proper ageing, proper mixtures, etc., constitute extremely important portions of the success or failure of a product. For instance, it seems to me that none of the manufacturers so far have used sufficient pressure to make retorts dense enough to exclude air and transmit the heat with the greatest degree of efficiency. I say retorts should be made by machinery, although the hand process is largely used here and also abroad. It is merely a question of getting the *correct* machine.

Now I do not wish to argue over points of manufacture at present, but believe a table showing the composition of a few ***notably good fire brick*** products will be interesting, mainly because they differ so much, and yet all are excellent goods.

ANALYSES OF FIRE BRICK SAMPLES.

Per Cent. by Weight of.	Sample from		
	Christy Fire Clay Co., St. Louis.	Stettin, Germany	Mr. West, England.
SiO_2	63.98	59.060	86.310
Al_2O_3	30.63	38.020	8.535
Fe_2O_3	3.13	Trace	0.815
CaO	0.51	0.410	0.500
MgO	Trace	0.097	0.116
K_2O	0.54	0.646	0.336
Na_2O	1.43	1.316	1.093
Total	100.33	99.839	98.294

The West brick is an acid brick, almost infusible. Some people claim a brick should be high in alkali for certain purposes, but it is difficult to determine.

Do not understand me to say that only one quality of brick should be used in a structure. It has recently come to my notice that the Carborundum Company of Niagara Falls, New York, markets carborundum grain or powder, which, when mixed with silicate of soda to the consistency of a thick paste, can be spread on fire brick about 0.0625 inch thick, and is said to form a splendid heat resisting and strong surface. We may be able to properly use such a device over cheap brick.

Recommendations.—At present I will recommend the following general points when asking for bids on benches, furnace linings, etc.

First—Specify that a certain quality of material shall compose each portion of the structure. If the manufacturers cannot show bricks of the same kind they propose to furnish, already in use and giving known good results, then request them to have satisfactory tests made, or withdraw from the competition.

Second.—Have it thoroughly understood that quality is demanded first and price second.

Third.—Have it thoroughly understood that each piece of material delivered shall be subject to rigid inspection by a competent man, and if not satisfactory *in every particular,* it will be rejected.

Fourth.—Insist upon workmanship being of the best, and also subject to competent inspection.

Fifth.—Take a live interest in getting first-class material yourself, and not the result.

Sixth.—Finally, do not buy of a certain manufacturer just because your grandfather in the gas business *invariably* bought of him. There are others in the field. Stimulate the competition for producing *better material,* and the manufacturers will soon take pride in their results. Remember, the best is none too good.

Conclusion.—It would be unwise on my part were I to attempt to say just how each manufacturer should produce his goods. Therefore I will leave the question with the foregoing comments, and sincerely trust that all gas men will make an honest effort to break away from "Cheap John" lines, so that we can better our results and keep pace with the rapid advance of modern progress.

I wish to add that certain manufacturers have kindly furnished me notes on fire clay products. Not wishing to incorporate them in this body of my paper, but being desirous of adding them to the stock of gas literature, they are herewith appended by permission of the gentlemen at the head of their respective firms. The papers are as follows:

(1) A letter from Lemon Parker to D. R. Russell, dated Janury 20, 1904.

(2) A paper read before the National Brick Manufacturers' Association in 1901 by Lemon Parker, with discussion by Mr. Stowe.

(3) Notes on Refractory Material for Gas Benches, by R. H. Miller, of the Christy Fire Clay Company of St. Louis, dated January 25, 1904.

(4) Notes of C. C. Hartung, of the Christy Fire Clay Company, dated January, 1904.

(5) Notes by George C. F. Vater, of the Christy Fire Clay Company, dated January, 1904.

(6) A letter from John Dell, of the Missouri Fire Brick Company, dated January 11, 1904.

(7) A letter from J. L. Green, of the Laclede Fire Brick Manufacturing Company, dated January 20, 1904.

APPENDIX.

Mr. D. R Russell:

Dear Sir:—Replying to your request for data for paper of W. A. Baehr, this is a very difficult and complicated subject and the field is so large that it is very hard to cover entirely. Beginning at the mine, clays which are for use under high heats have to be selected carefully by the miner before it is placed upon the car, as it varies largely in different locations in the same mine, also there is a great difference in chemical analysis of a clay found at the bottom, middle and upper section of a seam. I have noticed that there is a great difference in the shrinkage of clays coming from different parts of the same mine, also a difference in shrinkage of different strata. This shrinkage is caused by the variations of the physical and chemical nature of the clays. The amount of clay substance, quartz and impurities, change which might mean a large variation in the chemical analysis. In order to overcome this condition, clays have to be selected in the mine itself. After it appears upon the surface it is again selected and placed in piles where a refractory and high-grade clay is required. Where there is no special call for this, we simply use what is termed mine run, taken as it comes from the ground. Of course this selection adds to the cost of the clay. There are other factors, such as weathering, grinding and soaking clay before they are put in the pan and soaking after they leave the pan, all of which requires work and added cost, but at the same time means an improvement in the quality of the clay and should necessarily mean a higher price.

Again, in the manufacture, there are manipulations through which a high-grade clay has to go, adding to its cost, such as slow drying, which takes up quite a large surface of the floor, slow burning in the kilns, which means a less tonnage and high heats at a great expense for fuel, and care of the stock, all of which contribute to the cost as above stated. Where competition is met with, temptations to the manufacturer are to decrease his cost as well as his selling price. The costs are decreased of course, by some change in the manipulations which might have a tendency to lower the grade of the product. This is set forth to give an idea of the care necessary when a conscientious manufacturer does his full duty to the customer. Of course, there are many conditions which cannot be gone into which have their due effect on the refractory qualities. A clay for a gas bench should have a very high fluxing point, something like 3,100 degrees or more.

I have made numerous tests of the refractory points of clays and find that the best Chetenham and Oak Hill clays have a refractory point of between 3,100 to 3,200 degrees. This clay has a high reputation as a gas retort body. There are other clays throughout the state which have a higher refractory point, about 3,500 degrees, but due to their excessive shrinkage they are not adapted to such use, being of a more aluminous nature. While the clays of St. Louis are highly silicious, a recognized condition necessary for retort and setting manufacture, some of the most noted clays of this country and Europe used for retort manufacture are of this kind. I believe there are one or two exceptions, but I personally do not know of good results obtainable by manufacturers using an aluminous clay for retorts. As stated above, the more manual labor expended on any clay and the more you work them over, and the more care taken in the manufacture, the better the results, naturally with an increased cost. As to the actual manipulations necessary, almost every individual manufacturer has his own secret process, which if applied to any clay but his will not be successful, so different are the conditions which exist in clays. One factor in the successful production of a higher quality of goods is the length of time used in the manufacture while drying and burning, tending to improve the structure of the material, a thing which seems to be of small consideration in these days.

Should Mr. Baehr desire, I can let him see a paper I wrote in 1901 which covers the subject in a general way.

Very truly yours,

January 20, 1904. LEMON PARKER.

A PAPER READ BEFORE THE NATIONAL BRICK MANUFACTURERES' ASSOCIATION, 1901.

Geologically considered, clays are the result of decomposition of the highly feldspathic rocks, such as gneisses and prophyries. These minerals are the silicates of alumina, with soda, lime and potash, which by the action of the element slowly lost most of their alkaline constituents, some of the silica taking in water, and were converted into clays of varying range of use.

Where the clay is found near the place of its origin it is usually more impure, as it is found to be less free of the undecomposed quartz and mica, or even highly feldspathic in its construction; where clays have been worked over many times through geological areas and redeposited repeatedly, frequently quartz and mica are found to exist in perceptible proportions, together with evidence of the undecomposed feldspar.

Often there are differences in clays that chemical analyses do not make plain. The causes for variation in shrinkage of the same clay is one illustration; another is the apparent difference in the sandier nature in the plasticity of different parts of the bed. Again, there is the seeming sandier nature of the clay; all this is based on the assumption that the anayltical tests are found to run nearly alike, forcing us to look to another source for an explanation.

Supposing after burning the brick was found to be too friable. We know, or ought to know, that not only the plasticity, but any or all of the properties of clays when worked up into brick or tile are affected, not only by their chemical nature and by the mixture of different clays, but by a condition not usually recognized, that is, the mixtures of different materials in the same clay which might produce the same analysis in two clays of different physical properties.

Assuming this as true, how often, and how many of us in experimenting for a mix to adapt a new clay to certain uses, after submitting samples to a chemist, are satisfied to try the various mixes in a hit and miss kind of way, contenting ourselves with the report that this or that mix failed, or was not refractory enough, or other vague inference, when an intelligent study of the failure might have led to a true interpretation of the result.

In making an investigation of this character, we may find a large per cent. of the clay contains quartz and faldspar, which might be determining factors in the success or failure of a trial mixture, which known, might be corrected. While I am hardly prepared at present to form any definite opinion, I believe an analysis of this kind, while of no value to those engaged in the ordinary lines of medium fire-brick would be of great assistance to those engaged in furnishing material adapted to grades requiring a high vitrification, especially where the chemical nature of the fluxes is to be considered. In experimenting with certain clays this phase of the problem has forced itself upon me as an important factor, although a proper basis for a systematic study of the question is not so plain.

We all know that the English and Germans in the Old Country and some of those engaged in higher branches of ceramics in the United States, employ such an analysis as an auxiliary to their chemical investigations, and I should like to hear from anyone who can enlighten us as to its utility in the selection and its value in making mixtures of clays, for specific purposes.

Chemically considered, fire clay is a combination of the hydrous silicate of alumina, associated mechanically with silica in various states of subdivision, but sufficiently free from the silicates of the alkalies, iron and lime, and other fluxing impurities to resist vitrification at extremely high temperatures.

Due to their chemical condition, clays vary in regard to their refractory character, not only in different sections of the country but in the same mine, by being interstratified with useless layers largely charged with oxide of iron. The relative proportion of silica and alumina is in itself no indication of its heat resisting quality, as both, whether in combination as silicates or alumina or as free silica, are essentially the refractory elements of the clay, being unvitrifiable, except when associated with detrimental impurities, but clays containing free silica are found to be somewhat fusable in the pressure of 3 per cent. or 4 per cent. of fluxing matter, while an aluminous clay could stand as much as 6 per cent. or 7 per cent. of the oxide of iron without the loss of its refractory character.

Considered in relation to their use, the relative quantity of free silica seems to me to be very important. The fluxes being low and the grain, density and plasticity the same, there are conditions of use requiring a silicious brick. Others requiring a brick approaching a more neutral state, or again a brick of basic nature.

Problems like this do not confront us all, but it is a matter of great moment to those who supply customers in the steel or other trade, who use certain processes requiring clays of high point of vitrification and free from possible material that might be attacked by the metallic slags, thus creating an agent that would destroy the brick.

Manufacture.—In the actual manufacture of material, generally speaking, the strides made in improved methods and machinery are immense. In the memory of the present generation we have advanced from roller mills to dry pans. We have added wet pans, pug and auger mills, discarding the old chaser with its single roller. We have progressed from brick-making in wooden boxes to iron molds, and hand represses; we make end and side cut brick and repress by steam. Finally, we have reached the questionable stage of dry-pressed fire brick, all systems having their votaries. With all this we still make our tile in wooden molds in the good old-fashioned way.

The mad scramble for supremacy in the brick business demanding reduction in costs and improved methods, is largely responsible for the changes, some of them of decided benefit, while other improvements have been altogether of a questionable character, affecting the quality of the production of certain manufacturers in a disastrous way.

I believe in the progressive spirit of the age, but caution should be exercised in adopting an untried process or new machine. Who will dispute the fact that an old-fashioned hand-made brick is not the superior of the steam repressed mud, or the dry pressed fire brick of to-day?

Actual tests under trying conditions have repeatedly proved this to be a fact, and so well is it understood that customers requiring unvitrifiable material have been known to avoid a manufacturer whose inclinations run too much to mechanical aids.

Drying.—The question of drying is of special interest and a number of methods are used for this purpose. I have noticed in my trips around the country that most of my eastern friends use a temperature in their drying rooms that seems to the western man an extreme, the cause being, I believe, due to the difference in the physical character of the two clays.

There are a number of systems in use having the merit of economy; one, tunnel drying by waste heat from kilns through steam fans, seems to have many supporters, and probably certain aluminous clays would act very well under these conditions, but would it not be greater economy to use heat in continuous kilns? Another, tunnel drying by waste steam, is, in my opinion, a better method, but still open to the objection of excessive temperature and forcing.

Why not make the whole factory a drying room, using waste steam at a temperature that would not interfere with the men at work? This solution of the question is not only more in keeping with the traditions of the clay men, but it is actually the only safe method of drying when every factor contributing to the successful use of clay is to be considered.

Burning.—The chemical changes in the burning of clay consist—

First.—In the destruction of the carbonaceous matter.

Second.—The dehydration of the silicates of alumina destroys its plasticity.

Third.—The decomposition of the disseminated carbonate of the protoxide of iron converts it into an anhydrus sesquioxide to which the yellow color is due, and the conversion of the sulphide to the proto silicate which causes the black spots.

The paleness of the color of the brick is not always due to the absence of iron, as a large proportion of carbonaceous matter would tend to bleach, by reducing the sesquioxide to a lower oxide. Again, lime or other alkaline earths, which are fluxing agents, might reduce the coloring power of a large percentage of the oxide of iron by forming a pale double silicate of lime and iron. A properly burnt brick is uniform in color, and can only be obtained by slow burning.

A clay should be burnt in the kiln to a temperature nearly equal to that to which it is to be adapted. There are conditions which call for a brick burnt to a point where the fluxing matter is made to combine chemically with the refractory free elements in the clay increasing its power of resisting abrasion. This condition would be brought about by soaking the material in the heat for a long time.

Use.—The first brick manufacturer of to-day is in an entirely different position from that of his brother in the past. Then his customers were few and very accessible, and his competitors, his immediate neighbors, and the choice of refractory material a matter of local selection. His list of customers being limited the natural tendency was for each to cover the entire field afforded by the local market, making his production probably from one or two mixtures adapted to the use of his trade. Conditions to-day have entirely changed; not only is the whole market of the country open to some, but the conditions of use have completely changed, each branch of the trade demanding the best grades of material adapted to their use. The altered conditions were so gradual that almost imperceptibly the manufacturer has drifted into specialties, sometimes from choice, but as often from force of circumstances, as the adaptibility of a certain product has become recognized on the market as a standard of excellence in a certain line or lines.

To-day brick of certain well-known brands may be found in steel works, whether located in the eastern, middle or western states. Again clay goods of certain other characteristics obtain largely in gas works, whether located in Massachusetts or California, Canada or Texas, while middle and lower grades are still supplied from a local factory near the point of use. There is, it seems to me, much room for thought over the position of the manufacturer of medium brick in his relation to the market.

His quotations are largely used by some buyers in forcing the price of high grade goods down to the lowest limit, resulting frequently in the adoption of questionable methods of manufacture, not adapted to the requirements of the user, who probably imagines he has made a great bargain, only to find on trial the material lacking in some important particular for which the manufacturer is in his opinion solely to blame.

Conditions like this enter largely into the calculations of the progressive consumer and the wide-awake manufacturer, who recognize the value of the high standards rather than conditions of first cost.

In conclusion, I believe the manufacturer who studies his own interests will know the composition of his clays physically and chemically, using this knowledge to increase their value and will adopt only such methods of manufacture as are known by personal experience to be absolutely safe, in keeping his material up to the high standard.

DISCUSSION OF THE ABOVE BY MR. STOWE.

Mr. Parker has covered the ground so completely I hardly know what to say. The further one goes into the fire-brick business the less one seems to know. I started in the fire-brick business in a small town in Ohio about 20 years ago. Mr. Parker says it does not make much difference about the clays or percentage of silica. We are making fire-brick with 85 per cent. silica. I believe that the fluxing materials that we have to contend with are the greatest difficulty in the manufacture of fire-brick. It is a very easy thing to make a brick that will stand a heat of 3,000 degrees, but the same heat in contact with lime will melt at 1,200 to 1,500 degrees. Lime is the hardest thing to contend with in the manufacture of fire-brick. We know brick that would stand 2,400 degrees of heat but for the lime acting as a flux on the silica. Some years ago we were importing brick from Germany that sold for something like $200 per 1,000, but our manufacturers improved their product and to-day we are shipping brick to Germany, where five years ago they were shipping brick here. We are shipping brick as far as Australia for different purposes. I believe the fire-brick industry is further behind with their work than any other branch. I think it is a good thing that the N. B. M. A. should take up the work it has. The iron and steel industry is the largest industry we have and they are depending entirely on fire-brick. It is an industry that we look at with more respect than anything else. It was at one time almost impossible to introduce a new fire-brick in the market. Mr. Parker knows himself how it is, after a brick has made a certain reputation. The Mt. Savage brick has a reputation and the Harbison & Walker has a reputation, and although a new man may make better brick he would have hard work to introduce his brick. Now, steel works are coming to a point where they will not think of running their plant without a chemist, and you can have your fire-brick analyzed and so make it easier for the brick manufacturer to introduce his article. I visited Mr. Parker's plant last year, and although they have an entirely different kind of clay for making brick, they make a brick that for certain work is better than any of the German brick. Germany used to supply the gas retorts of the country. Now St. Louis supplies them. It is only a matter of development in this business that will make it one of the most important in the country. The question of manipulation of clays is one that has to be looked after in the manufacture of fire-brick to a greater extent than any other part of the business. We have to first look after the mechanical part of it, and then after the analytical. The little specks of iron that would not make any difference in the shape of paving or building brick would make our brick run and give us a black eye. I think if the fire-brick manufacturers would take more interest in the National Association and get together and study these things we would learn something. I attended a meeting about two years ago, at Pittsburg, of the fire-brick manufacturers. There were present about 20 or 25 men interested in brick. Mr. Harbison was made President and I was made Secretary, and we talked the matter over before the meeting. Every man thought he was in the right and every other man wrong, and I do not believe they have got together since. No other meeting was ever called, and so the "Fire-brick Manufacturers' Association," that was to be, died abornin'.

REFRACTORY MATERIAL FOR GAS BENCHES.

For some time past there seems to have been a tendency on the part of a large number of gas engineers to secure their bench material at very low figures, quality not seeming to have been taken into consideration. As a result the manufacturers who have made a specialty of this class of work have found it necessary to make such changes in their methods as would enable them to make a slight profit.

In a number of cases the gas engineers have gone to nearby concerns which are not prepared to handle material of this nature and were able to secure their requirements at a very low cost. The result has been that the large manufacturers have been practically whipped into line and forced, not only to reduce their prices but quality as well in order to keep on the right side of the ledger. It is a well-known fact that material used in bench settings, as well as retorts, should be made from mixes, or batches, which should receive aging and treatment before working into blocks. This practice is followed by manufacturers in preparing blocks for glass furnaces and pots and is the only way in which a high grade as well as a satisfactory article can be secured. At the prices which the manufacturer receives at the present time for bench material, as well as retorts, they cannot afford to age or treat their batches or mixes, merely taking them, as one might say, from the pug mills to the moulds. This means a greater shrinkage as well as the using of clays which have not formed an affinity for each other. Some people seem to think the treatment of clays is not necessary, but practices in the iron and glass business have demonstrated that it is an essential feature. Now, this means the storing of material for a given period, and in order to prevent drying out it means attention from time to time in the matter of turning, wetting down and tempering of clays.

The great trouble in gas bench settings seems to be due to the shrinkage which takes place after the benches have been built. This, in a way, can be accounted for by improper calcining of burnt stock. A great many manufacturers recognize this fact, but owing to the low figure they are receiving for material and the knowledge that the "other fellow" is not doing this, forces them to deviate from the proper method, but at the same time they are compelled to do it.

In the matter of fire-brick it is well known that a brick made from raw clay will shrink considerably, especially if the temperature attained in the gas bench is greater than the kiln in which material is burnt. As a rule the benches are run higher than the ordinary brick kiln. The best brick are those made of a combination of raw and burnt clays, which means a more dense and compact brick as well as a brick that will have a minimum shrinkage. The low price feature again enters here. In a great many localities there are manufacturers who make brick from the raw clay, and as freight may be less than from a point where a well-made brick can be obtained, it is either a case of the manufacturer who furnishes the higher grades of material to make a raw-clay brick or else lose the sale of the material. He is then forced to either buy this cheap brick or allow the gas engineer to order the cheap grade.

Should these raw clay, or cheap brick, many of which are made from inferior clays, be used, the result will be that a certain part of the bench will give away, which means a settling of the upper part, *i. e.*, the settings and retorts. We all know that when a bench starts to settle the retorts have a tendency to crack, and when this happens it means the elimination of this retort, and this in turn a reduction of capacity in the bench which could undoubtedly have been avoided had the gas engineer specified a higher grade material. When one or two of the retorts out of a bench are shut down, it means that the cost of making gas increases considerably as the same amount of fire is used whether you are furnishing seven or nine retorts. And, while this is the case, there is also a large amount of coke, by-products and gas which is being lost owing to causes which, in most cases, can be traced to inferior clay material in some part of the bench.

All the manufacturer asks is a fair profit on his product, and when an engineer insists on certain prices he can rest assured that while he will get the material the quality will not be what it should.

A feature which has not been mentioned above is a selection of clays for this class of work. There are in all clay mines numerous grades of clay and unless price warrants it, it means that the run of mine, or, in a great many instances, clays that have been picked once are used for bench work, the higher grade having been selected for some other purpose.

When the gas engineer sees fit to specify certain clays, and is willing to pay a reasonable price for this material, the results obtained in gas plants in this country will be far greater than at present, and the expense of material will not be nearly so great as the benefits derived. Respectfully submitted,

R. H. Miller, *Sales Agent and Engineer.*

MEMORANDUM.

Modern practice in all industrial branches calls for the greatest economy in the operation of their plants in order to meet the ever growing competition of other manufacturers. The first step toward this end is the selection of the proper apparatus adapted to the intended purpose. Nor must the first cost of an installation stand in the way of being chosen, if its efficiency is such as to offer decided advantages over other systems. The greatest production from a given amount of raw material, at the least cost and in the shortest space of time, is the aim pointed at. These considerations hold good under all circumstances and in all branches of whatever industry, but they are of especial moment in such plants where the product is of such character that unless great precautions are taken this product may become wasted by leaking or otherwise escaping. This is eminently the fact in the production of lighting gas. Apart from the fact that the raw material, in this case coal, must be treated so as to yield the fuel efficiency stored therein, the product itself must be guarded against waste to which it is easily subjected. The proper type of the bench being decided upon, same being well planned, the erection thereof must be most carefully executed. This applies to all parts of the structure, including recuperators, retort settings, retorts and enclosing walls. Among the various constructions in use the recuperative system is at this time regarded as the most efficient and being best adapted to meet the demand that can be made of an apparatus of this kind. Being gas fired, the room formerly taken up by the grates is available for the accommodation of additional retorts, thus increasing the output considerably without also increasing the expense for fuel. This, however, is only one advantage gained. The fact that the running of the fires is constantly under full control, that the temperatures can be raised to the degree that experience has found to be desirable and that the heat can be so directed as to embrace all retorts alike is of the greatest interest, insuring an almost perfect uniformity of the work both in operation and in output.

The retorts nowadays are manufactured from fire-clay, all other parts of the construction, with the exception of the doors, being of the same material. The temperature may, therefore, be raised to the highest desirable degree, this being sufficiently high to attack and destroy any weak part of the construction and great care must be taken for this reason to employ only such clays that are able to withstand the action of the flames, or, in other words, are refractory. Bearing in mind that the retorts are opened from time to time to withdraw the coke and recharge with coal, it is easily seen that frequent and sudden changes in the temperature of these retorts must take place. The retorts must be able to withstand such changes without becoming injured, the life of a retort counting for years. They also must not wear off to any great extent during that time, nor must the clay from which they are made contain impurities making them liable to be affected by the coal in the course of distillation. It is also essential that the material be dense on account of the gaseous nature of the product which would find an easy way of escape. Of course, any existing pores in the retorts would soon be closed by the gas-graphite generated and deposited as a coating on the inner side of the vessels, but a certain loss would occur in the meantime. Every part of the apparatus must fit very closely and remain so, thus making it necessary that no shrinkage should occur after the bench is put up. This is especially essential in the settings of the retorts. The latter would be easily disturbed and endangered by any great disarrangement of their supports. The recuperator flues would not perform their work if through shrinkage any leak should occur. The air necessary for combustion could not be properly heated for the correct management of the fire, and in this manner a loss would be incurred by reason of the reduced percentage of distilled gases.

To sum up, the clay from which the materials are made which are used in the construction and operation of a gas producing plant must not alone be refractory, but also burn dense at a comparatively low temperature, and the ware must burn without losing its shape. Apart from the chemical analysis which does not always agree with the obtained results, experience and care of the clay manufacturer is of the greatest importance, as he must select the material with a view of meeting all the difficulties mentioned above. C. C. HARTUNG.

Christy, Mo., January, 1904.

NOTES ON FIRE-BRICK TO BE USED IN THE CONSTRUCTION OF RECUPERATIVE GAS BENCHES.

In considering what kind of material should e used in the construction of Recuperative Gas Benches, there are to be considered in special the following parts constituting a bench:

(1) Gas producer.
(2) Recuperator.
(3) Main body of bench, including retort settings.
(4) Retorts.

Gas Producers.—As it is common use in gas benches to operate each bench with a separate producer, this producer is directly connected with the bench. In such case it is most economical to work the producer as hot as possible. Therefore, even if, as usually done, a water pan is arranged under the main producer (a certain amount of water is then evaporated and in passing through the hot coke some water-gas is formed, making a certain amount of heat latent, which becomes available again at the point where the main combustion takes place), the demands on the material forming the walls, etc., is great. In addition to the action of the heat, in the lower part of the producer from the grates up to as high as the bed of coke reaches, the action of the ashes under the influence of the heat is to be taken into consideration. In order to overcome this, only good, very dense fire-brick with smooth faces and of, as it is usually, though not quite exactly termed, basic character; that means, that its analysis should show a large percentage of A 12.03 should be employed. For the upper part, any good dense fire-brick, which will stand the heat without shrinking and melting off will do.

Recuperator.—The recuperator has to act once as a means to convey the combustion gases to the stack and the secondary air (for combustion) to the point at which the combustion takes place, and second, as a means to transmit the heat yet stored in the combustion gases to the air for combustion. The influence of heat on the brick or tile constituting the net-work of the recuperator is not great, as readily will be seen. The air enters with a temperature equal to that of the atmosphere and reaches its point of destination (if the recuperator is designed right) with a temperature of about 950 degrees Fahr. The combustion gases will leave the main bench vc. enter the recuperator with about 1,000 degrees Fahr. and leave the recuperator with about 450 degrees

Fahr. The conditions in the recuperator always being the same on each place, no change in temperature taking place, the recuperator brick and tile will only have to answer the following requirements:

(1) They shall be absolutely straight and true, without cracks, and of a character that insures easy cutting, in order to allow an absolutely tight and workmanlike construction. All shrinkage shall have been taken out of them in burning.

(2) They shall be of a dense, smooth and hard burned make-up to allow as perfect transgression of heat as may be obtained with fire-clay material.

Main Body of Bench, Including Settings.—Where the air is leaving the recuperator, it meets with the gas, forming perfect combustion, which usually will take place with about 2,500 degrees and 2,600 degrees Fahr. It will be readily seen that the material used in these places (burners) should be very refractory. As it is true that the denser a refractory material is made up the more resisting it is under equal conditions otherwise, these burners should show this quality and should be turned very hard. The same would apply to all the settings for the retorts, as the average temperature in the main bench, if economical conditions prevail, will be about 2,200 degrees Fahr. As to the setting blocks they must be made up to just fit the retorts and should be absolutely true, so as to allow convenient setting without too much of time wasting, cutting and grinding. They should be turned at higher temperature than is exacted on them in the bench, so that no shrinkage can occur while they are performing their duty, thus endangering instead of bearing the retorts.

The walls surrounding the main bench should also be highly refractory and dense smooth fire-brick. For the main arch, thrown over the bench, there should be used arch brick made up of highly refractory fire clay grogged with burned fire clay as usual under an addition of a sufficient amount of quartz, which will insure a non-shrinkable material, but be kept in such limits as not to make it grow more than to allow tight closing of joints.

Retorts.—The retorts form the most important, and, at the same time, the most expensive part of the gas bench. It is therefore well worth while to consider exactly what requirements they have to fulfill, and that the best on the market is just good enough, and as in so many other cases, the cheapest. A retort that is well made up and of the proper material and composition, will pay its cost by its longevity, which, by the way, should be about one year, and by economical operation. The requirements of a good gas retort are:

(1) That it be made up of a good fire resisting material which does not shrink nor grow any more at the temperatures from 2,200 degrees to 2,500 degrees Fahr. about, prevailing in the main bench.

(2) That the material show the highest degree of indifference against frequent and extensive changes in temperature, that is a tenacity usually not peculiar to clay-ware.

(3) That the body of the retort show a great resistibility against mechanical attacks, which occur every time the retort is drawn and loaded, and especially when the retort graphite is being removed.

(4) That the inner surface be absolutely smooth to facilitate the removal of the graphite.

The clay or clays used for the retorts shall, of course, be absolutely free from the iron pyrites or lime pebbles (as most of the retorts and settings in stock at the Indianapolis Gas Works, August, 1902, showed in a very bad way).

Some fine hair-like cracks can hardly be avoided and fill up very soon with graphite. They may even act favorably as to better resistibility against sudden change in temperature. This, of course, shall not speak in favor of the extensive net-work of wide cracks to be seen in the greater part of the retorts on the market, which merely suggest that the preparation of the material used and the make-up are not at all up to the requirements.

It may be mentioned yet, that in some places the retorts are glazed or enameled inside. But this helps only for the first short time to facilitate the removal of the graphite, and besides tends to make the retorts sensible against changes in temperature.

Christy, Mo., January, 1904. GEO. C. F. VATER.

CORRESPONDENCE.

Mr. W. A. Baehr:

DEAR SIR:—Your esteemed favor of the 6th was duly received, but absence from the city a few days has prevented a prompt reply. I fully appreciate the remarks made, and think that our class of material has been sold under such strong competition that prices have been cut below what the best material ought to bring.

Of course, when prices are so low, it will affect the quality of the goods. We can all make a better grade of material whenever the gas companies are willing to pay a better price. This is true in all lines of manufacture where quality counts. Your field of investigation, as outlined in your letter, is a pretty broad one, and I do not see how I can give you any special information that would be of much value in your paper. But I am willing to assist you in any manner that I can with any information that might be of use, and will try to call on you in a few days and personally talk over the matter. However, it seems to me that the proper correction of this state of affairs is in the hands of the gas companies. If they are willing to pay better prices, they can, without doubt, also get a higher quality of material, especially in the way of brick, furnace blocks and settings. Of course, every factory has its special grades, and the best grade of one company may be better than the best grade of another company, as one manufacturer may have better knowledge of the right process for making the best material. After you get what the manufacturer considers his best material, it is only then by a crucial test you can determine what has the most merit and is the most suitable for your requirements.

These questions do not apply to the quality of our retorts, as we make but one quality of retorts and aim to make them of the highest possible grade for durability. We permit nothing in the way of expense to interfere with the quality of our retorts. No matter what price they are sold at, we do not allow the selling price in any manner to interfere with the making of the retorts.

If there is anything in this letter that you care to use, you are perfectly welcome to do so. Hoping to see you personally in a few days, I am
Yours very truly,

January 11, 1904. JOHN DELL, *President.*

Mr. W. A. Baehr:

DEAR SIR:—Replying to yours of the 6th, I have tried to give you in the following an outline of the clays as used by this company in the manufacture of material for gas benches.

The refractory materials used in the construction of gas benches are usually fire clays (impure, hydrated silicates of alumina.) The impurities generally found consist of oxides of iron, lime, magnesia, alkalies, etc.

Clays are rarely used singly or in their raw state, but require admixture, one with the other, as well as mechanical treatment, to adapt them to the requirements of the brick, tile or retorts, as the case may be. Raw, untempered clays when used alone invariably contract and crack when exposed to high temperatures, and the expansion and contraction encountered in gas benches, thereby causing fissures and settlements which quickly destroy the efficiency of the bench.

Clays are refractory in proportion to their basic character; that is, to the amount of alumina they contain, and are less useful as they become silicious (acid) in their character; while the presence of ferrous oxide to the extent of 2 per cent. or 3 per cent. renders most fire clays useless for high temperature work. Alkalies, when present to the extent of from 1 per cent. to 2 per cent., render fire clays fusible at high temperatures. Lime and magnesia, when in but small quantities, make most fire clays comparatively fusible. Owing to the facility with which lime and silica combine to form a fusible silicate, it is necessary to avoid using clay containing lime in any furnace where it may be exposed to a white heat.

The value of fire clays depends largely on their freedom from calcia carbonate, iron pyrites and ferrous oxide. Any of these at high temperatures will combine with the free silica of the clays to form fusible silicates. The presence of 3 per cent. or 4 per cent. of the foreign oxides in silicious clays will render them fusible, but aluminates, even 6 per cent. or 7 per cent. of ferrous oxide, does not destroy its refractory quality. The presence of oxide of iron has a strong fluxing effect and 2 per cent. or upwards affects the fusibility of clay.

The following analysis will show the character of the fire clays used by the St. Louis manufacturers:

Cheltenham Fire Clay:

Silica	61.22
Alumina	25.64
Oxide of iron	1.70
Lime	0.70
Magnesia	0.08
Alkalies	1.31
Manganous oxide	0.45
Water and loss	9.68

Flint Clay Used in Settings and Retorts for Grog:

Silica	42.19
Alumina	44.12
Oxide of iron	0.78
Lime	0.18
Magnesia	0.12
Alkalies	0.19
Loss and water	12.42

Fire brick, tiles and retorts, as manufactured by the Laclede Fire Brick Manufacturing Company from the above clays and their mixtures are of various grades and structure, suited to the different conditions encountered in furnaces and distinct parts of furnaces. The mechanical arrangements of the particles in brick, tile or retorts materially affects their power to resist heat and also the expansion and contraction occurring in gas benches. Generally, the coarser the particles the better the material will stand. It has been the practice of manufacturers in the past to use the same material in all parts of benches, excepting in the retorts where a higher grade of material has been used in some instances. This, we have learned from experience, will not do. We have found that the generator arches require a high grade material for the reason that many times through carelessness or ignorance, sufficient coke is not kept in the generator or there is a leak in the charging door. This causes combustion of CO_2 to take place in the generator and the result is the melting of the arch tile and nostril hole blocks, and the letting down of the settings and the retorts. We have found it necessary to make all the material composing the combustion chamber and also all of the settings, of high grade material. This we find greatly prolongs the life of the bench.

When a bench starts to settle or let down and the retorts become cracked or out of shape, the fault is nearly always in the settings about the combustion chamber where the greatest heat is encountered. We have yet to find a case where the retorts have been melted down. We do not find them cracked and ready to fall to pieces, but in most cases it is from abuse where they have been exposed to undue expansion and contraction, by a constant change of heats or by leaving them with the mouth-pieces open for long intervals. I have seen men in retort houses throw water into retorts when drawing them. There is no fire clay material made that will stand such treatment.

Too much importance cannot be given to the drying out of the benches after their erection. Rushing new benches is very often the cause of their never giving satisfaction. It causes all manner of troubles in the bench, especially leaks in the recuperator tile.

Another thing which I believe to be the cause of much trouble in many works and the early letting down of the benches, is the ignorance of many retort-house foremen as to the operation of the air slides on the recuperative benches. They do not seem to realize the effects the movement of one-eighth of an inch or even less will have on the benches.

This cannot be too strongly impressed upon them, as it is the cause in nearly all cases of the inefficiency of the bench.

I am taking the liberty of sending you samples of the material used by our company in the different parts of the bench. Sample "A" is unburned retort clay. You will notice the mixture of the plastic and flint clays. "B" is material used in settings, combustion chamber and in generator arch. "C" is material used in generator walls and "D" material used in recuperator tile and arch tile.

I hope this will cover the information you asked for, and I sincerely hope you will find time to visit our factory, as I am sure you would be able, by a personal visit, to get a better idea of the process of manufacture than I could possibly give you in this way.

Yours very truly,

LACEDE FIRE BRICK MANUFACTURING COMPANY,

January 20, 1904. J. L. GREEN, *Vice President.*

P. S.—You will find among samples one marked "E." This is made entirely from flint clay of above analysis. This material is used only for furnaces carrying the highest heats, such as open hearth steel furnaces, etc.

DISCUSSION.

PRESIDENT MCILHENNY:—This certainly is a most valuable presentation of the subject by a very able man. I would say that the paper which Mr. Baehr presented to the Ohio Association last year attracted a very great deal of attention and most favorable comment, even from foreign publications. Gas journals abroad quoted it freely and commented very favorably upon it. I have no doubt the paper just read will receive as favorable comment as did Mr. Baehr's former paper. We would now be glad to have a discussion upon it. Mr. Dewey, have you anything to say on the subject?

MR. V. F. DEWEY, Detroit, Mich.:—Mr. Baehr's attitude on this subject was first brought to my attention by a conversation I had with him. I had taken up the question at Detroit and had given it considerable thought and study. I am firmly of the belief that gas men, and particularly gas engineers, ought to pay more attention to the subject. I think we have fallen behind and have not made the progress and research along this line that we have in some other lines of the gas business. The subject was brought very forcibly to me in the same way as has been suggested by Mr. Baehr, and that is, with reference to the flue linings of our water-gas generators. We are at the present time making some analyses and tests of fire-brick and fire-clay material, getting our samples from almost all the manufacturers, and while I cannot yet give any definite results, I believe from these experiments we shall soon be able to determine, in our own minds at least, from whom and what kind of materials we shall order in the future. Another matter that was not brought out in the paper, although I believe it is important, is the fact that certain qualities of fire-clay material are necessary for a certain use. For instance, the fire-brick material that may be suitable for the lining of a water-gas generator, might not be suitable for the lining of a carburetter or for bench construction. In other words, it is quite possible that we should study the subject from a chemical standpoint. There are certain substances or ash which, combined with the carburetted material, cause fluxing or fusing at a very much lower temperature than fire-brick would naturally fuse under different conditions, and the consequence is a destruction of the lining of our generators, due to that very trouble, the ash combining with the fire-clay, or the iron, possibly, in the fire-brick material, lowering the fusing point and consequently resulting in the rapid deterioration of the brick. As I say, I am not ready to take any positive stand on this subject. I am only seeking information.

MR. DOHERTY:—I have never given close consideration, Mr. President, to the character or materials used for construction. In planning the work for the research department of this Association, I have made out specifications for testing the material, but they are still in a crude form, which will involve a determination of the expansion co-efficient or the effect of gases at high velocity and the tensile strength of the material, and the compressive strength, the idea being to outline specifications and then try and induce somebody to take up the subject of the study for the research department and see what they could give us of value. That is as far as I have gone on the problem of the character of material for construction. I would prefer to call this contribution of Mr. Baehr a report, rather than a paper, because the original intention was to have some one working on bench construction and operation all the time, and reporting progress at each meeting of the Association, and really it would therefore be a progress report each year. My attention has been more directly towards the operation of benches, and perhaps the most important benefit to be derived by gas companies is to go into the question of operation thoroughly and try to bring the more poorly constructed benches up to the standard of the best, and the more poorly operated benches up to the benches which are operated in the best mode. The operation feature is one that would bring the most important results to the gas companies. In the question of construction, a great deal depends upon the material, and a great deal depends upon the heat conductivity of the material. As you perhaps know, they have made some extended experiments in Germany on different qualities of material for coke-oven processes. They are now using silica block in one plant, which is a material which cuts down the time required for carbonization. With most of the coke-oven plants, the heat is taken up by the regenerators and is given off again and the conductivity is not so important perhaps in a coke oven of the regenerative system of working as in the gas works where we use recuperative benches and where we pass our heat from one flue to another through a well of fire-brick. Fire-brick is a poor heat conductor. If it can be made a good heat conductor, and at the same time retain its heat resisting properties, or have its heat resisting properties increased, we can materially improve the operation of benches and also cheapen their construction. We have been working for several years on this subject and I am trying to think now if there is anything that I can anounce which will be of value in the operation of benches as a result of our research that was not covered in my report to the Western Association two years ago or in Mr. Baehr's report to the Ohio Association last year. I don't believe there is anything new that I can say, but I think a reiteration of the necessity for keeping the fuel-bed of uniform depth, or perhaps it would be more proper to say, of uniform resistance, so that one portion of the fuel-bed will not be doing more work than it should, or more than its proportion of work, is an important consideration to be kept in mind. The importance of using no more water than is necessary to prevent clinkering and the necessity for regulating the supply of air after analyses have been made of the flue-gases, is also important. Another point which may or may not have been covered by Mr. Baehr's paper—I know I spoke to him about it at the time—was the necessity of operating the stack dampers so that the least differential pressure will exist between the waste gas flues and the incoming air flues. The effects of the inlet dampers on the primary and secondary air are readily understood. It is generally assumed by the operator that an opening of, say, 1 inch, will give 25 per cent. more air. Now, the relation between the opening in that damper and the amount of air passing through the flue, is not necessarily uniform at all. The resistance of the flue may so far exceed the resistance of the damper that the damper produces no congestion whatever, and after you reach that point you can throw your damper wide open and it does not make any difference. I can also show any of the members, if they care to see it, a bench operating, closed up absolutely tight, and no secondary air being supplied, and yet the flue-gas showing only 14 per cent. CO_2, where it should show 21.5 per cent. CO_2 by volume, if no excess of secondary air were being supplied.

Now, one great trouble with our present benches is the leakage in the bench and leakage in the full depth benches—and by full depth bench I mean that bench where both primary and secondary air are pre-heated—in the full depth bench leakage will often be so excessive that very little of the air passes through the regular flues, and most of it leaks out around the door and leaks through the cracks of the brick work. We have to have tighter joints for our recuperators and we have to operate them more carefully to prevent their cracking and developing leaks through use. It is also possible to patch the leaks in a recuperator while the bench is in operation. We have done this much in the same way you patch a retort. The leakage in the recuperator determines to a great degree the economy of the bench in various ways. It is not as important as it might first seem under certain conditions of operation. If the fuel gases reach the top of the waste flues at 2,000 degrees, any leakage of secondary air through to the flue-gas flues will lessen their temperature and lessen the amount of heat, which can be picked up and carried back by the secondary air, and the difference in actual temperature between the products of combustion just before they enter the waste flues and after they have made about one lap, will show the considerable leakage which occurs, as the loss will be evidenced by a flue gas analysis.

PRESIDENT McILHENNY:—Mr. Mann, have you anything to say on the subject of bench construction?

MR. HOWARD E. MANN, Cleveland, O.:—The material we use is what we have been using for a great many years. We insist on our material coming up to the specifications supplied. For several years we imported a German material which we used in our combustion chamber, and for the past three years we have been using material made in the States, which we find to be as well adapted to the purpose as the German material. That is all I have to say I believe.

MR. OSBOURNE:—In reference to water-gas, some of the gentlemen seem to have had either very bad material in their generators, or I have had a different experience from that noted. I have noticed the material used by us lasting as much as four years in the generators, and three years is not an uncommon thing in a hard-worked generator working every day practically except a few times when it was down for the purpose of being overhauled. I think some of the trouble is due to the size of blocks used in the generator. In some of the smaller work especially, they use a block cut or made to fit a certain circle. This is true in a good many instances, at least I am quite sure, because I know you can send to the Laclede people and get from them blocks cut to fit a certain machine which are made by the manufacturers, and which will go right into the particular circle of a particular generator. These blocks, in a good many instances, are quite large, and when one of them starts to go to pieces, the whole block is rendered useless. If it is large, of course it makes a large opening which gets to the shell of the generator much more quickly. I have noticed that the best results in lining these generators are obtained by the use of smaller pieces conforming to the circle, the smaller portion towards the fire, so that when it breaks it makes a very small opening; just like small window glass in a window, if one is broken it does not affect the whole window to nearly the same extent as it would if the panes were larger. I think some of the trouble in our generators has been occasioned by the use of too large blocks.

PRESIDENT McILHENNY:—Are there any further comments on this paper? If D. R. Russell is in the room we would be very glad to hear from him.

MR. D. R. RUSSELL, St. Louis, Mo.:—Mr. President and gentlemen, I unfortunately got in late and have had no opportunity to examine Mr. Baehr's paper until it was read here this morning. I glanced over it and feel that it is certainly a very valuable contribution to gas literature. The position Mr. Baehr takes in regard to the quality of material I think is correct. No manufacturer can produce goods or sell them at a low price—I mean by that, at cost of manufacture plus cost of selling, and continue very long in business. He has to make a profit somewhere. It is a very easy thing to dig clay out of a mine, rush it into your works, pass it through the machinery, push it out to the consumer, and yet your money out of it and make a profit at a much lower cost than it will require another manufacturer who is honestly trying to produce a high-grade of goods. In the first place, a manufacturer of fire-clay should carry at all times at least twelve months supply of raw clay on his dump so that it can and will be properly weathered. No matter how high the grade of clay is, the weathering process will bring out impurities. Again, the clay should be carefully picked. An expert man going over a pile of clay will see with his eye the impurities which very often are in the shape of nodules which do not disintegrate by the weather. He can pick these out. Then the clay must be properly manipulated, and to do it properly, the company must have a large and extensive plant covering different kinds of machinery used for different purposes and different grades of mixture. Furthermore, to secure competent skilled labor, the manufacturer must pay a good round price. I think it is more important, or as important, to have experienced men manipulate the clay products in the course of manufacture, than in any other line of business that I know of. Take an experienced machinist and put him at a lathe, and in a short while he can take up almost any line of special work and adapt himself to it. But in fire-clay goods the looks and appearance of the material and the feel as he rams the retort (the resistance that is offered) all indicate to the experienced fire-clay man the consistency of the material. The feel or the resistance indicating the density, will determine whether he will ram it hard or light. Now to obtain that result you have to pay good wages to your men.

In manufacturing water-gas material, or materials for water-gas linings, you have to contend with a great many things. Take for instance, one kind of oil, it will affect a certain kind of brick in a way differing from another kind of oil. You have also to study the conditions that prevail in certain sections of the country. As a rule, one section of the country will get a different grade or kind of oil than another. You may supply brick at one point that will cost just as much to manufacture as another, and yet will not do nearly so well for the purpose. Another important consideration is to have the right kind and shape of block for linings, and also the right grade of brick for the checker work. In bench construction we all know a great deal is dependent upon the mason work. It has a great deal to do with the life of a bench. The joints, of course, must be laid close, and instead of being pointed up with clay or soft mortar, the brick should be cut where necessary to conform to the wall as laid, and if it is necessary to use for any reason rather a large joint, a great deal of ground brick should be mixed in with the clay and make it stiff and then have it well packed. To secure this class of work only the best and most experienced masons should be employed and they invariably command the highest wages. The shape and design of the blocks have a great deal to do with holding up the retorts. The retorts may be very excellent, but if not set on properly designed blocks, the blocks themselves will give way, permitting the retorts to sag and the bench in a short time goes to pieces. Also the bench should be designed if possible to keep the heat uniform, not concentrating it at one or more points. Otherwise, it will destroy the blocks or retort at that point and your bench will go to pieces in a very short period of time. I honestly believe that we can and do make in America as good retorts as are made in the world. I believe that the blocks manufactured in this country are as good as those made abroad. I thing the results have shown it and will show it. They claim in Europe a longer life for the retorts than they do in America, but they do not carry the high heats over there that we do here. As a rule, they run six-hour charges, while over here the rule is to run four-hour charges. Therefore a retort will last longer and may produce a little more gas during the life of the retort on that side, but when you take into consideration the extra heat you have on the retorts in America, you can readily understand that they will go to pieces a little sooner. It is like driving a horse rapidly for a short while, or driving him slowly for a longer time. I agree with Mr. Baehr in his statement that if there was a disposition on the part of the purchasers to insist upon it, there would be a better average production of fire-clay goods. There is always a tendency, in every line, to buy as cheaply as possible. Fire-clay goods, however, are harder to select from or judge by analyses than any other production that I can think of. The appearance does not always determine it. Take certain clays, that by the analyses would show a very high grade, and they are of a high grade, but owing to the component parts of the clay, although it will stand a very high heat, even as high a heat as any other material, will shrink enormously, thereby letting down the retorts, or if it is a water-gas set, it will open up the joints and let the fire get in and destroy the lining. I think about the best way to determine that is to put the brick under test. To do that is rather difficult, as a special constructed kiln is required in which you can produce enormous heats by the use of oils or other fuel with a forced draft. This subject is a very large one and it is impossible to cover it in a short while. I believe that is all that I could add to the valuable contribution which has been offered by Mr. Baehr.

Mr. Donald McDonald, Louisville, Ky.:—It seems to me the question of the chemistry of fire-clays is such a big one that it is utterly hopeless for the ordinary gas man to expect to go into it thoroughly. What we could do, would be to have the experience of all the gas men as to how long the manufactured product of certain fire-clay people does actually last in the practical work of gas manufacture. That is about the only thing, so far as I can see, that would be of any substantial or practical value to the ordinary gas man. When you say that a gas company should be willing to pay higher prices and thereby get better goods, there is simply no sense in it. It doesn't necessarily follow that a high price will insure good goods. If a fire-clay manufacturer comes to you and makes certain representations as to the quality of his product and says, "here are my goods," how can you find out whether he is stating the facts or not? Chemical analysis means nothing. To expose a fire-brick to a high heat means nothing. It may stand a high heat, and not be able to stand chemical abrasion. The only thing that will enable us to secure the best products would be to have some central point to which we could write and find out from actual experience how long a particular brick will last in the practical operations of gas manufacture.

Before we leave this subject, however, I would like to get the experience of some gas man on the point that my friend mentioned with reference to the generator linings wearing out a little above the grate bars. My experience has been that the linings in the carburetter and the superheater are as good to-day as they were four or five years ago when they were put in, but the generator linings immediately above the gratebars were gone in less than one-half that time. In attempting to replace them you naturally let the work above, down a little. Now I have seen a publication to the effect that cement could be made of carborundum, or some other material, with which these bricks would be brought out to their original surface, and yet be hard enough to withstand the wear. If there is any gentleman here who has had any experience on this subject, I for one would be glad to hear from him.

Mr. Moses Coombs, Youngstown, Ohio:—One thought has occurred to me in reference to this valuable paper. It seems to me it is one of the most interesting papers we have had, and it is certainly very instructive. But Mr. Baehr proceeds to some extent at least to discuss the question from the manufacturer's standpoint, as to what kind of material we should get from them. I think there is another thought to be considered on the other side. I believe that the manufacturers in a general way attempt to furnish goods that are intended to be satisfactory. But I believe that some gas companies so handle that material as to place the manufacturer in a wrong position. It has been noticed that if we receive the same material at different works, at one of the works it will give very satisfactory results, and the same material at other works will not give nearly so satisfactory results. I think that it would be a matter of profit to all of us to have some one who is qualified write a paper on the uses and abuses of good material. I thing there are two sides to that question.

President McIlhenny:—That would be a very timely topic and we will hope to have some such subject treated at a later meeting.

It was then moved, seconded and carried, that a hearty vote of thanks be extended to Mr. Baehr for his very valuable and instructive contribution.

President McIlhenny:—We will next take up the department of Novelty Advertising and New Business Methods.

Mr. B. W. Perkins, of South Bend, Ind., then read the following:

NOVELTY ADVERTISING AND NEW BUSINESS METHODS DEPARTMENT.

B. W. PERKINS, EDITOR.

I have the following to report under the head of Novelty Advertising and New Business Methods Department:

No. 1. Irvin Butterworth, Detroit, Mich., writes: "When weather and our orders will permit, we have a coke parade in the streets. On one afternoon we hired a band, and made up a procession of loaded coke wagons, including our own and many from various dealers, and marched through the principal streets preceded by a brass band, each coke wagon containing a placard 'Genuine Gas Coke,' etc.

"So far as possible we fill our coke wagons at night with orders for the following day, and start them off in a parade each morning from the works, the procession remaining intact as long as possible as the various wagons go through the streets on their way to the customers' houses. This scheme costs little, and is quite effective.

"For the purpose of educating and qualifying our employes for pushing our business we are conducting this winter a series of Saturday night lectures on various subjects pertaining to the gas business. For instance, one evening we had an expert from the Welsbach factory at Gloucester, N. J., who delivered us a lecture on the Welsbach burner. Next Saturday night we shall have a lecture on the Gas Meter by an expert meter maker. On the following Saturday night arrangements have been made for a lecture on the subject of Gas itself. These lectures are attended by from 150 to 200 of our employes, and are proving beneficial. At the close of the lectures light refreshments are served."

2. Earl H. Buck, Vincennes, Ind., uses an eight-page booklet in which he tells how coke is made, why it is more economical than hard coal, why it will not injure stoves or furnaces, the value of coke as a general fuel, how best to burn it, etc., together with the price. These booklets are distributed throughout the town, and he says have been a great aid in disposing of his coke.

3. C. Edgar Titzel, Lancaster, Pa., says: "We advertise that we will give water heaters away, charging $5 (which is the cost of the heater) for connecting same. The first year we were in business, that was in 1902, we sold 725 heaters, last year we sold

about 300. During the same season we employed three or four good solicitors for the purpose of selling stoves, heaters, etc., paying them a commission of 10 per cent. on all sales. We have been very successful in doing a large business in this way.

"We have never done any newspaper advertising, all of our advertising having been done by circulars, personal letters, and large posters. In regard to methods used, I would say that I can hardly tell which method we did use. We simply hustled after all the business in sight."

4. Wm. B. Johnson, Madison, Wis., used the following:

"We have an electric sign composed of 25 blocks extending across the street in front of the office on poles about 35 feet high. The blocks are 13 inches wide and 19 inches long, with 25 receptacles so arranged that by putting in lamps it is possible to make any letter out of any block. With this sign we can make any 'ad' that can be spelled with 25 letters.

"In the business district of the city, we have two blocks with five six-glower Nernst lamps in each block suspended in the center of the street, the merchants located on the street thus illuminated paying enough each month to cover our charges. These lights are burned every evening from dusk until 10 o'clock, the complaint man turning them on and off.

"This we fill with coarse coke, and have about 15 red automatic Hylo lamps distributed around so as to be near enough to the outside to show the light, but not near enough for the lamps to show.

"In the day time people that pass stop to look at the coke, and at night when the lights are burning, it looks as though the coke were on fire, and attracts considerable attention."

He also advertises to thaw out water pipes by electricity.

5. S. O. Fulkerson, St. Charles, Mo., says: "We carry a card in each of our daily papers and agree to pay $1 for information leading to the sale of a gas range. The card contains a blank form for name of prospective consumer, also name of claimant. None but old consumers are eligible. Upon receipt of signed claim we acknowledge it and file it in order as it comes. Last year we paid over $100 on claims. You see the old consumer recommends it and places himself in an embarrassing position when it comes to a kick. If properly carried out, it will increase a company's business 50 per cent. Such has been my experience."

6. F. H. Sawyer, Norfolk, Va., writes the "Street Railway Chat" and the Gas Company's Catalogue. Samples of each are herewith enclosed and explanatory notes of each as follows:

"Street Railway Chat" is an advertising and information leaflet issued weekly by allied gas, street railway and electricity companies located hereabouts. These leaflets are placed weekly in brass pockets arranged on each side of the car within easy reach of the passengers. Several thousand leaflets are issued on Saturday of each week and pockets are kept well filled for the first three or four days after leaflets are issued, but the supply is usually exhausted by the third or fourth day. This indicates that the leaflets are eagerly sought for by the riding public, and I have no doubt from the number of complimentary expressions that we have heard on all sides that the advertising matter reaches nearly the whole population of the town. It has been the aim to make this leaflet short, bright and to the point, and to contain information and advertisements that are especially desirable reading matter to the public.

Now, regarding the catalogue issued by the gas company, will say that we have long since come to the conclusion that the majority of the gas customers are not acquainted with the various makes and styles of gas appliances. They may know what a gas range is, but have never heard of a gas water heater; may know that the company sells a bath-room heater, but have never heard of a gas grate; may know that the gas range is a good thing, but complain that the old waffle-iron that was used on the coal range cannot be satisfactorily used on the gas range, not knowing that there is a special waffle-iron made for the gas range. In fact, the idea first suggested to our minds was to let every purchaser of any gas appliance know something about every gas appliance that the gas company sells, and in reference to radiators to show a cut of the radiator and also give size of room that it would heat, and now we find that people are coming in with the leaf turned down in this catalogue telling us exactly the kind of radiator they want, deciding themselves as to the kind best suited for them. This catalogue contains also cuts of Welsbach lamps, Humphrey arc lamps, gas furnaces and the Monarch water heater, churches using gas for heating, and a short write-up for coke, also for tar. We do not expect to sell any gas furnaces in Norfolk, yet I am sure the idea of inserting a cut of one of these in our catalogue was a good one, just merely to make something to talk about."

7. F. H. Sargent, Lawrence, Mass., says: "In regard to 'New Business Methods' and 'Novelty Advertising,' I would say that trying to sell gas means that we must sell the appliances. We do not sell fancy gas fixtures, but leave this to the city gas fitters, but we do sell side brackets, at about cost, and we do some fitting to connect up these brackets, at very nearly the cost. The idea is to get a new consumer, whose home has never been piped to use gas. Then, again, in trying to sell a gas range to parties having no pipes in their kitchen, we pipe them free of charge, with a light in the kitchen. The idea of this is to get them to use gas for lighting in their kitchen during the winter months as well as the summer.

"Our scheme for selling ranges is as follows: We lay in our stock of ranges for the season, about February, then we start to advertise extensively; our ads. read: 'Special discount for March, 20 per cent. from our selling prices. For April, 15 per cent., and May 1 and after 10 per cent.' We do this because parties who intend buying a range see this ad., and order in March. This gives our fitters a chance to set up a good many ranges in the spring, and it relieves us of the congestion in May and June. About April 1 we start our canvassers out and try and push the gas-stove business all we can until July 1; then, of course, the rush is over. Giving this extra discount we find that 30 per cent. of all the stoves we sold were sold in March, 22 per cent. were sold in April, 17 per cent. in May, 10 per cent. in June, and after July 1, 21 per cent. We think this a good scheme and have profited by it. I would also say that we sell and set up ranges practically at cost. Advertising is certainly a help to any gas company in trying to dispose of ranges, not only newspaper advertising, but the distribution of booklets, and posters for bill-boards distributed in all parts of the city.

"In selling heaters we have no special scheme, only a large supply constantly on hand in our show room, during the fall and winter months. We make a specialty of a small cylinder stove, which we sell for $1. In the fall we fill our show windows up with these heaters, and placard the windows with signs relative to the heaters. We have done very little with water-heaters in the past, as the expense of them is more than most people want to pay, but the coming season we hope to get up some scheme or hear of some novel way of disposing of them. We cannot use anything but brass heaters here."

8. M. H. Cutcheon, Appleton, Wis., says: "The only idea I have at present which I have never seen used is: Furnish a small coke-burning heater for kitchens at a nominal cost, to make a present of the heater with a five-ton order for coke. In this way stimulate the sale of fuel gas in winter as well as the sale of coke."

9. Henry I. Lea, of the Western Gas Construction Company at Ft. Wayne, Ind., gives us this: From Evanston we supplied four towns, and for each town employed an independent card index, arranging the streets alphabetically, and houses numerically, having one card for every single house, and a card for each flat, in case of apartment buildings. On the front of this card was a list of all of the appliances which we might hope to install for domestic use. On first making the round, the solicitor, having this card, indicated on the front of the card the exact number and nature of gas appliances in use in this house or flat. On the reverse side is a series of questions covering this same range of appliances in the following manner:

" 'If no gas range, why not?'

" 'If no bath-water heater, why not?'

"Opposite each of these questions the first solicitor makes note of the objection given which prevents his sale of the appliance in question. These notes are all of permanent record. The next solicitor, in making the same round (and, by the way, we never send the same solicitor through a territory twice in succession) has for his guidance the objections previously given, and my plan was to arrange for each particular case some way of overcoming the objection first given. If the second solicitor fails to sell the apparatus he must record the objection given to him, and when the third solicitor makes his round, he has instructions to overcome both of the objections previously given in some special manner, which we can afford. This method of going after new business proved very satisfactory indeed, as I was able to more than double the previous year's sales of appliances under old methods."

10. H. M. Moore, Austin, Texas, says: "I am a strong believer in solicitors as a means of increasing our consumption. I started in the business as a solicitor, and flatter myself that I have made a good record as a business getter. My plan has always been to tell prospective consumers as nearly the truth regarding the use of gas as it is possible. The question is usually asked, 'What will it cost for a family of 2, 3, 4, 5 or 6, etc.' I

simply tell them that I am unable to answer such a question, as some large families use less gas than some small ones. 'What is the average cost per month?' is another almost universal question. I answer this by stating that there is no average cost that can be applied to all, as some people are economical, while others are extravagant in the use of gas. If a solicitor knows his business he can sell more ranges and secure more light consumers in one year than five years' advertising will do. In nine months I sold 329 gas ranges besides looking after the entire business of one town—laying mains, running services and piping houses. Nine years would not have done this in two towns by advertising, as I was enabled to meet all their objections and answer all their questions, which could not have been done by an advertisement system. I did not use one dollar in advertising during the year 1903 and yet put out 130 gas ranges in this, about as poor a gas town as there is, owing to past poor service. By dealing honestly with the people their confidence can be gained and business increased in any community. I hope to remove all the prejudice against our company here, and get a large increase by my personal solicitation. Our business was increased by 10,000 cubic feet per day during the last year. The two towns referred to above have a total population of about 12,000."

11. J. N. Dickerson, Dunkirk, N. Y., writes: "The only bid we make for business is that we do all work from main to house, and do it as cheap as possible, and when we are done and they are ready for gas, send bill to them. If this is new to you, you can credit us with the system. We control about twelve plants and this is the only one we do all the work in; last year it proved to be very satisfactory to us and to the customer."

12. C. N. Whiting, Boston, Mass., says: "The past few years we have adopted a system of advertising by using small printed slips with gum backs, attaching them to our bills. The result of this method has been very gratifying. From time to time we have placed advertisements in the daily papers, but it is very hard to estimate the benefit that this has been to us."

13. R. Shacklette, Adrian, Mich., writes: "We confine ourselves to direct statements in the newspapers mostly. The 'cheap power' advertisement obtained for us a consumer on a 25 horsepower engine with a guaranteed consumption of 5,000,000 per year for a period of five years."

14. J. W. Wren, San Francisco, Cal., says: "The best method which we have found for pushing the sale of gas appliances has been a liberal use of newspaper space and a persistent canvass by solicitors. If there is anything better than this, we should be glad to hear of it."

15. Irvin Butterworth, Detroit, Mich., adds this: "As to the request for a statement of new business methods, I will give you something on this subject in a day or two. In the meantime I might call your attention to the little scheme that is mentioned on page 76 of the January 12th issue of the *Journal of Gas Lighting.* It describes the placing of a card by a gas company that maintains Welsbach lights, conspicuously on the walls of the various stores, stating: 'The lights in this store are maintained by the gas company.' I am sending you by this mail a photograph of a scheme for advertising coke which we are using in our office, and which you may deem worthy a place in your novelty advertising department. It represents a glass showcase attached vertically on the four sides of a square column in the lobby of our main office, each of the four faces of the case containing coke of a separate size, and the whole device representing the different sizes of coke which we market. Underneath this case is a table also surrounding the column on all sides, upon which consumers write their checks, etc. The exhibit is very conspicuous and cannot fail to be seen by practically every person who enters the office."

16. F. R. Smart, Jr., York, Pa.: "Inclosed you will find a copy of our 'Gas Herald.' This is a scheme of advertising stoves, fixtures, etc. It is published once every month in all local papers and a number of copies struck off for delivery as dodgers by canvassers. It is devoted to the uses to which gas may be put, and is also a means of communication between ourselves and the public. We try through its columns to educate our people to the use of gas and how to get the most good from the least consumption.

"You will note in this number, under the head of 'propositions,' that we offer to place a bracket in a bedroom free of charge when the house is piped. We selected a bedroom with the idea that people liked to have their neighbors know that they use gas, and placing a light where we do, does not make it evident that the tenant has that luxury, and for this reason they are much more liable to buy the fixtures for their hall and parlor. The results have been very satisfactory, as at least 50 per cent. of those receiving brackets have returned for fixtures in other parts of their houses, and before the year is up we hope to have other fixtures in all."

17. B. C. Cobb, Saginaw, Mich., writes the following: "We are great believers in newspaper advertising and patronize our local dailies extensively.

"We also use our gas bills for advertising purposes and think this a successful method. Sometimes we simply print across the face of the gas bills some particular thing we wish to call attention to. Other times we use small stickers, attaching them to all bills going out of the office. We are firm believers in street car advertising. We have also from time to time issued attractive pamphlets, describing and illustrating the advantages of some certain article. Have done this most extensively in the coke business. We have thought it advantageous to make free service and fuel connections, and have followed this plan since we got control of this property. We have had several days when heating stoves were given away, charging only for the connections. This was successful for some time, but the idea is worked out.

"We are now planning to make a house-to-house solicitors' attack to find out exactly how many people use gas and for what purpose, and how many use coke, and if not, why not. This information will be compiled in our office systematically by street and number, in order that our new business department may follow up each particular case where there is a chance for any new business.

"The Grand Rapids Gas Company, I believe, a year or two ago, sent up on a certain day several thousand kites with advertising matter printed thereon. They also had a scheme in Grand Rapids which I believe was first used in Denver, of letting a lot of dogs loose about the town, covered with blankets with advertising matter thereon.

"We have been very successful in piping old houses for illuminating gas, and our method in this has been to pipe and fixture houses of five rooms or more on a flat contract price. Price on fixtures and piping being figures at about cost or a little less, we assuming that the majority of customers would exchange some of the fixtures given on contract for more expensive ones, upon which we would make a profit. We have piped in the last two years between 1,600 and 1,700 houses, with a net loss of not more than $250 for actual work, material and everything."

18. F. H. Hutchinson, Camden, N. J., says: "I take pleasure in sending you under separate cover in compliance with your request two copies of the Gas Appliance Catalogue issued by this company, compiled by the writer some four months ago, with which we inclose a return postal card, and with which we have had quite some success in the South Jersey division of our company. We have originated no new ideas in particular in our new business department during the past year, but we find that our best and largest sales are made by forwarding circular letters to prospective consumers on the lines of our mains who are not using gas for illuminating or fuel, calling their attention to the prices at which we install house piping, fixtures and gas ranges, which is later followed by a house-to-house canvass by our solicitors."

19. Dr. M. M. Fenner, Fredonia, N. Y., says: "I have learned how to collect our bills. We made an agreement for a 25-cent advance on account of rise in price of coal, then gave it back to users if they would pay their bills. They paid up and continue to discount, and we find business much more pleasant."

20. W. A. Aldrich, Spokane Falls, Wash., says: "Pipe old houses at a little above cost, putting in fixtures which are paid for in installments."

21. Chas. R. Price, New Bedford, Mass., writes: "In the sale of gas stoves, our plan is to have two prices for stoves, one price which is as close to cost as is consistent with business methods—for we do not believe in giving away things at large discounts from cost in order to stimulate the business. Thus, if a stove costs us $11.50 delivered at our works, to sell it at a fixed price of $12 delivered and set up with 15 feet of connected pipe, if needed, free. The next price on the same stove is to add $4 to the $12 as above; this $4 entitling the consumer to 5,000 feet of gas, the regular price of gas being at $1.10 net, per 1,000 feet. We find this is quite an inducement to people who are using a gas stove for the first time, as well as others who know of them and their usefulness and convenience, in that they feel free to use this low-priced gas for experimenting, and do not condemn the stove if the first time it is used for baking, they do not meet with the success which they have ordinarily had with their coal stove. Our purpose in giving them the gas in this way is explained to the consumer to induce them to experiment and see what can be done with the stove. All meter bills, until the consumption of this gas is accomplished, are filled in in red ink and receipted.

We have usually put the limit on these sales, that the gas should be consumed before the expiration of the year.

"We believe by these means we have induced many of our customers to get in the habit of using the stove freely, and that is good advertising on our part.

"In addition to this, we use the daily papers, especially during the stove season quite freely, as well as the backs of our bills, which are changed each month and printed in different colored ink each month. I enclose you samples of these bills so that you may see the character of our advertising in this direction."

22. E. M. Osbourne, Valparaiso, Ind., sends us the following: "One of the best advertisements in our business is the Kern burner. It saves the gas per burner, and does away with two-thirds the number of burners, the people are satisfied, and we find satisfied consumers an advertisement for us.

"In February, 1903, we placed a few of these burners in a pool-room, stating if they were satisfied, well and good—if not, it would cost nothing for the trial. They proved very satisfactory, and believe this customer sold at least 100 of these burners, and he has proved a good friend and talker for us. Since then over 800 of these burners have been placed here with scarcely a kick. We use a Holophane spreader for stores and the down-throw globe for dining-rooms and libraries. They give about 100 candles, with a consumption of 3.5 feet per hour at 0.20 pressure.

"We advertise coke in the daily papers, with much success. We make the 'ads' as attractive as possible. We offer small quantities for trial free, and one trial seldom fails to bring further orders.

"We do not crush our coke, but find demand for all we make for furnaces. Some of the best known men here use coke and hard coal, and have given us a statement of results favoring coke. People believe these statements, while they do not always take what we say sincerely.

"Our gravel roofers use coal-tar almost exclusively, and like it.

"We opened a fitters' department here last spring. The company never having done any work of this nature before, just allowing customers to have work done anywhere they pleased. This department paid here, the profits being sufficient to pay for all distribution work. Besides this, the work is uniformly done, and carefully tested, inspiring confidence in our patrons.

"While we can do this work much cheaper than plumbers do it, the profits enable us to maintain two or three men, who can be sent out on trouble work promptly, thus giving our patrons the idea that we are really interested in giving them good service. We have pushed water heaters and other gas appliances with good success."

23. M. T. Walker, Ft. Madison, Ia., says: "Relative to the Advertising Department of the Ohio Gas Light Association, I wish to give you a little incident which happened in a town in which I once lived which demonstrates the wide-awake spirit that every successful gas manager should have.

"During the Spanish-American war some United States soldiers were stationed there and one day, through the accidental discharge of a Krag-Jorgensen rifle, the bullet pierced a hole through the plate glass window in the postoffice without shattering the glass. Nearly every one entering the postoffice during the following week were interested to see the place where the bullet had gone through. A wide-awake merchant took advantage of this occasion and placed a little card just above the bullet hole, "Buy your books and stationery at Allen & Constantine." This proved to be a very fine advertising medium, and I give it to you in case you desire to use it in your department of the Association work."

24. E. M. Highlands, Clinton, Ia., says: "Replying to your recent favor regarding novelty advertising, would say that it has never been the policy of this company to go into any novelty or humorous advertising schemes, we believing that as gas is a perfectly legitimate commodity, that it should be handled in a dignified manner. We have mailing lists covering every department and when we desire to increase the sales in any one of these departments we mail personal letters or postal cards to cover the list, then use the follow-up system to get the results. This we find to be cheaper and more effective than newspaper advertising and we have obtained most excellent results from the above method."

25. F. P. Vogl, Claremount, N. H., uses a card index ledger showing five years on a single card, which he thinks is a decided help in the small gas business.

26. M. N. Latta, Charlotte, N. C., states: "We have found street car advertising most profitable, and inasmuch as the card spaces in the cars are all contracted for, I have utilized the spaces occupied by the mirrors in the cars and have pasted over them

such advertising matter as the enclosed poster (a semi-circular card).

"I also send you, under another cover, a copy of a cook book which I compiled, in combination with testimonials from various gas range users of this city. Testimonials and recipes were solicited and a prize offered for the best, and inasmuch as the contributors are all women of more or less prominence, and these have been very generally distributed in house-to-house work, the ad. has been an extremely good one."

27. Gas Company, St. Charles, Mo., writes: "We offer $1 to any person handing us the name of a party who might use gas and to whom the claimant has recommended the use. If said deal is consummated by us, the party making such claims is paid the commission. We have quite a string of checks to send out each month since the scheme was started last April.

"We have a regular insurance department, charging 10 cents per light per month. Our men in this department spend two days each week on the insured lamps. While there is no direct profit at the same time it insures a good light at all times and gives a general satisfaction which our phenomenal increase in sales of gas for the past two years will show. At the spring of the season we send a man to every customer and put their stoves and hot plates in condition. The increased 'send out' is at once noticeable."

28. R. J. Marks, Lexington, Ky., says: "I got some very good lighting customers from the electric company with the gas arc lamp and tip-top service. When I took charge of the plant there were only about 25 gas arc lamps in town. Now I have about 200. I install arc lamps free and charge 25 cents per month for cleaning and maintaining them where they use less than five. Over that number no charge is made other than for the gas used in them. I find no trouble in holding my own with $2 gas against 12 and 10 cents per kw. for electric light, with a 10 per cent. discount. My success I attribute to a better light and good service.

"With gas stoves, I start early in the season with booklets and advertising matter, which I leave at every house on the gas mains and in any new territory we expect to open up. Later on this is followed up with another lot of advertising matter left in the same way, keeping the newspapers hot in the meantime with our story. When it commences to get warm, we put a solicitor in the field canvassing the entire territory. We pay our workmen $2 each for every stove they sell during the season, not paying them anything until fall, when all stoves are paid for. So far I have not sold any stoves on the easy payment plan, and consequently have no unpaid stove bills, or gas stove junk. When we sell a stove and it is set in place, we have our workmen instruct the person who is to operate it (thoroughly) as to the best and most economical way of handling the stove. Then we follow that up with a lady who just drops in for a few minutes and talks stove, and shows them anything they do not understand. We simply keep going after them and telling them our story.

"Our company does not think it wise to sell fixtures; we make water-gas. We do nothing in the appliance business except sell stoves and Welsbach supplies. Our price for fuel gas is $1.25 per 1,000, but with that we sell some stoves and expect to put out a good many this season."

29. G. H. Rettew, Selma, Ala., says: "I cannot submit any novel ideas in the way of securing new business, but might say I have doubled the gas sales in one year for my company by persistent advertising in papers, sending out cards with bills and furnishing a book of rules with some reading matter and cuts, and this latter has proven very satisfactory. A consumer secured for illuminating gas receives one of these brochures and is naturally interested in the rules, thus reads a part at least and probably reads nearly all the book, and very soon we make a sale of a hot plate, water heater or something of the kind.

"The conditions here are very different from those obtaining in your section. Nearly everyone in your section is familiar with all kinds of gas appliances and if they don't use them it is because they don't want to. Here we have to educate the people to use, before the demand is created."

30. F. W. Stone, Ashtabula, O., says: "We had a float in the labor parade last September. This was not a novelty in itself, but on the float we had a gas range which was supplied with gas by two common 40-gallon Range boilers in which the gas was stored at 90 pounds pressure. A supply of cookies was provided and also some pastry from which two chefs made and baked cookies which were distributed to the crowd. The hot cookies demonstrated that 'gas' was 'Hot Stuff.' Appropriate banners decorated the float. The advertisement took well."

31. The Ideal Manufacturing Company, Detroit, Mich., suggests the use of iron toys as a novelty in advertising gas appliances.

32. T. W. Humphreys, Poughkeepsie, N. Y.: An illustrated magazine on the subject of gas appliances and general topics of the home interest. This idea is used by a furniture dealer in our vicinity with considerable success, and would apply to the gas business as well.

Issue attractivly gotten up circulars on good paper, treating with one subject only at each issue. These distributed in a manner which will put them directly in the hands of the consumers.

With a card which would compare in design and quality favorably with any other cards used in that particular city.

Post the required number of attractive posters according to the size of the city, which posters must be of the very best style and make-up.

Printed with mimeograph or a regular press with typewriter type. The circular letter to be signed by the superintendent or manager and addressed to the consumer or non-consumer as the case might be.

The above methods, together with a house-to-house canvassing, would make a very effective campaign.

33. Thos. D. Miller, New Orleans, La., writes: "One scheme that we worked here last summer, to get rid of a lot of old shop-worn stoves, was to advertise to give them away, parties paying $15 for gas in advance, to be used in one year. In this way we succeeded in getting rid of 2,000 stoves which we were finding great difficulty in selling at $5 a piece. We are following up these sales in hopes of selling them better stoves, as soon as they fully appreciate the advantage of the gas stove.

"We are just beginning a series of district cooking schools and will try and interest the various ladies' societies, giving them a special course of lectures. I believe this is going to result in great benefit to our gas range business."

34. Wm. McGregor, Pawtucket, R. I., uses a very novel scheme for the sale of coke. He uses a paper bag that holds a little less than a bushel, fills it with crushed coke and wholesales them to grocery stores, etc., who in turn retail them to their customers. He informs me that quite a lot of coke is disposed of in this way. The writer used the same scheme in the introduction of coke by taking a wagon load of filled sacks with two solicitors

working a street at a time, selling them the coke on the spot, and then at the end of the week they were to go around and secure orders for larger quantities. We have found this a very excellent way to introduce it, as people can try it for a very small outlay. The samples of printed matter received from the different contributors were presented for inspection.

Mr. Perkins:—Another method of advertising not embodied in the prepared report and employed by us is to build a cheap shanty and in it install a gas range, and when main extensions are made just keep the house along the line of pipe, and in this way exhibit the workings of the stove to the residents and passers-by along the street.

In conclusion, I may say that if the enthusiasm and energy displayed by our worthy Secretary, Mr. Jones, in his campaign for new members, was followed up to the same degree in selling stoves it would prove a very profitable scheme.

DISCUSSION.

President McIlhenny:—This is a very able paper and we are all indebted very much to Mr. Perkins for his zeal and ability in handling it so well. It is a department that attracts as much attention throughout the country as any other single branch of the work of the Ohio Association. I know that I have heard many favorable comments from all quarters as to the value attached to this department by gas companies in general. The companies utilize the ideas presented here in obtaining new business by adopting some of the novel methods suggested and of which they would otherwise not have knowledge.

Mr. Schwarm:—Mr. President, there was a little scheme brought to my attention a few days ago. A fellow dropped into the office to sell rubber stamps and pads. I was busy then and did not have time to talk with him. I asked him for his card. Instead of handing me a card, he just drew from his pocket a "sticker" and pasted it on my desk. It is there yet, and will probably always remain there. It occurred to me that the same method might be followed up by canvassers for gas stoves when calling on the women in the kitchen.

Mr. Charles L. Watts, Ashland, Ohio—I tried a scheme last fall of offering the employes 50 cents for every application for the use of gas. We have employes who secure as many as 20 contracts in a month at the rate of 50 cents, and this has worked so well that this spring we started in, the first of March, by offering 75 cents for each application. Some of our employes have turned in as many as 10 applications so far this month at 75 cents. We find that they spend all of their spare time looking after new business, and when we consider the amount paid goes to our own employes, and also consider the small amount it costs per consumer, I think it is a very excellent way of soliciting new business.

Mr. Perkins:—I would like to ask, on behalf of the department, that the members throughout the year would keep in mind that advertising is a very important feature of our business, and that contributions used exclusively for the gas business are not wholly necessary. Advertising schemes used in any other line of business can be remodelled and utilized in the gas business, and some of the very brightest methods have been employed by merchants and other business men not connected in any way with gas interests. The conclusion referred to in this department is the result of 650 letters. I do not think there is the importance attached to this subject that there should be, and I ask, on behalf of the department, that each of the members keep the department in mind throughout the year, and whenever opportunity offers to send in such material as they can.

President McIlhenny:—That would be a very easy way of remembering to send in contributions when the time arrives for it. I think we are all very apt to neglect doing these things and depend upon others to supply us with different kinds of information. We should adopt the Golden Rule and endeavor to give out something as well as obtain something. If we would all endeavor to select something and send it in the result would be vastly better.

Mr. Stone:—In No. 8 it is suggested to furnish a small coke burning heater for kitchens at a nominal cost, or make a present of the heater with a 5-ton order for coke, and in this way stimulate the sale of fuel-gas in winter as well as the sale of coke. We all want to sell our coke, and some of us want to sell it pretty badly. I would like to know if there is a line of stoves made on purpose for use in burning coke.

Mr. W. C. Boyle, Cleveland, Ohio:—I saw some circulars last fall from a Chicago firm making a proposition of that kind and saying if I would give the name of the dealers in our place they would bother us no further with an attempt on our part to try to work up the business. But I cannot just now give the name of the firm.

Mr. Osbourne:—We use, quite successfully, a little sheet-iron stove. I do not know who makes it. It costs about $3 and we sell them at about $3.50, depending, of course, on the size of the stove, and use a grade of coke consisting of the smaller sizes. We, however, have no trouble in selling our coke without any device of that kind. A good demand for it has been created and we seem to be able to get rid of it at a good price. There is, however, a refuse that is left from screenings and then the small parts that come out about like a chestnut in hard coke. This burns very readily in these little stoves, and some of the poorer classes of people are using it to a very good advantage. Some people get it in their head that they have to buy a special stove, and we cannot get it out of their heads even by showing them it is not true. So there is a demand for some kind of a stove like that. When they find that they can get a stove for $3 or $3.50, and demonstrate to them by using the coke, of which we furnish a small amount free, they use these stoves. We have sold a good deal of our refuse coke in that way, so that we do not have any refuse left any more. There is a demand for it, and the people use these little stoves. It is a little drum affair, and stands about three feet high. It is of very cheap construction and seems to last three or four years, from what I can understand.

Mr. McDonald:—I would suggest that a little jet of gas ought to be used to ignite. I think it is a practical suggestion and is followed in many instances. Use a jet of gas to ignite the coke.

President McIlhenny:—That is certainly a good idea.

Mr. Stone:—The scheme suggested by Mr. McDonald I think is all right. In Ashtabula, before we had natural gas, there was quite a number of places where they would use gas in the summer in a small stove and in the winter time they would abandon it and go back to the old range, and we rigged up a lot of bunsen burners and attached them, and in place of using kindling they would stick a bunsen burner into the stove and start the fire in that way. It helps out the gas company in pretty good shape.

A motion was then duly made, seconded and adopted to tender to Mr. Perkins, as editor of the "Novelty Advertising and New Business Methods Department," a vote of thanks for his very valuable contribution."

President McIlhenny:—We will begin promptly this afternoon at 2 o'clock, and will first take up the Report of the Committee on Uniformity of Gas Meters, and which I am sure will be a very interesting one. After concluding that subject we will take up the Question Box.

On motion, duly seconded and carried, the meeting then took a recess until 2 P. M. of same day.

SECOND DAY—AFTERNOON SESSION.

When the Association met at 2 P. M. President McIlhenny first asked S. F. Hayward to present the

REPORT OF COMMITTEE ON MEMORIALS.

To the Ohio Gas Light Association:

Gentlemen:—Your Committee on Memorials respectfully submit the following:

ASA S. BUSHNELL.

Mr. Bushnell was born in Oneida County, N. Y., September 16, 1834, and died in Columbus, O., January 15, 1904.

In 1851 he settled in Springfield, O. After several business ventures, he, in 1867, became interested in the Wardner, Bushnell & Glessner Company, of which he was later the head.

He served through the Civil war, being captain of Company E, One Hundred and Fifty-second O. V. I., and was later very prominent in Republican state and national politics, serving two terms as Governor of Ohio.

His strong characteristics were his courteous demeanor, inimitable humor, tireless energy and sturdy integrity. He was a man of wide business capacities and large charities.

He was one of the organizers of the Ohio Gas Light Association and a charter and honorary member; also an active member of the Western Gas Association from 1883, and for many years was President of the Springfield, O., Gas Company.

W. A. STEDMAN.

Mr. Stedman was born in Newport, R. I., December 9, 1837; died at his home in Framingham, Mass., November 8, 1903.

His education was acquired at Newport, R. I. In 1862 he became connected with the Newport Gas Light Company, and shortly thereafter its Superintendent and Manager. In 1887 he became interested in the American Electric Manufacturing Company of New York; through the manipulations of others the venture was not successful. Returning to the gas business, he became engineer and superintendent of the Laclede Gas Light Company, St. Louis, Mo., but subsequently resigned to become Vice President and General Manager of the Flatbush, L. I., Gas Company. He remained in this position until July 1, 1903, when he resigned to retire from active business cares.

He was a man most highly thought of by his associates in both his business and personal capacities, and will be remembered as a man whose individuality was markedly distinct. He took a prominent part in the gas industry. He was a charter member of the New England Association of Gas Engineers and its Fourth President; member of the American Gas Light Association from 1877, and its fifth President; member of the Society of Gas Lighting, and prominent in the Guild of Gas Managers. He served through the Civil War, and late in life as colonel of the Newport artillery.

He was elected to this Association March 18, 1887, and subsequently to honorary membership.

EUGENE VANDERPOOL.

Mr. Vanderpool was born September 2, 1844, in Newark, N. J., of a prominent family, and died July 12, 1903.

He graduated from Princeton College in 1864, completing his education at Rensselaer Polytechnic Institute at Troy, N. Y. Upon leaving college he was for a short time in the employ of the Morris and Essex Railroad Company. In 1866 he entered the employment of the Newark (N. J.) Gas Light Company, in 1867 was made engineer, and in 1871 became its President, which position he held until 1895, when the company was consolidated into the Newark Gas Company, after which he remained as one of the trustees for the bondholders of the Newark Gas Company. He was interested in numerous other enterprises, among which were the Montclair Gas and Water Company, the Morristown (N. J.) Gas Company, and the American Gas Company, of Philadelphia. He was prominently connected with banking and other fiduciary institutions in Newark. He was an active member of the American Gas Light Association from its second meeting and President in 1855. He was instrumental in founding the Society of Lighting, was Vice President from 1884 to 1896, and President from 1896 until his death. He joined this Association in 1887, being subsequently made an honorary member.

He was not a seeker after public office, but positions of public trust were thrust upon him, which his public spirit caused him to accept and discharge.

BURGESS L. MCELROY.

Mr. McElroy was born August 25, 1858, in Monroe Township, Knox County, Ohio. He prepared for college at Kenyon Military Academy, graduating from Butler University, near Indianapolis, Ind., in 1882.

He was an active Republican and held numerous public offices. He was also interested in a number of business undertakings. At the time of his death, he was Secretary and Treasurer of the Millersburg Electric Light Company, President of the Hillsboro Light and Fuel Company, and practically owned the gas works at Wapakoneta, Ohio. He was elected a member of this Association March 21, 1900; died June 28, 1903.

Respectfully submitted,
STERLING F. HAYWARD,
JOSEPH LIGHT,
ERNEST F. LLOYD,
Committee.

It was then moved and seconded and duly carried that the report of the Committee on Memorials be accepted and spread upon the minutes.

PRESIDENT MCILHENNY:—The next order of business will be the report of the Committee on Uniformity of Gas Meters.

CHARLES S. RITTER:—Mr. President and gentlemen, the materials which were used in making up this report were compiled from answers to a series of questions sent out to meter manufacturers and gas men. I feel, as chairman of the committee, as though we should apologize to the Association for not being able to submit a report with some definite conclusions. There seems to be, however, no uniformity of opinion among gas men as to just exactly what is wanted, and I think perhaps the development of gas meters has been somewhat retarded because the gas man has not understood it any better than he has.

Mr. Ritter then submitted the following

REPORT OF COMMITTEE ON UNIFORMITY OF GAS METERS.

To the Ohio Gas Light Association:

GENTLEMEN:—The Committee on Uniformity of Gas Meters begs to submit the following report:

For some little time after this committee was appointed, which was in June, 1903, very little was done toward a definite plan for proceeding with the subject. A few desultory letters were exchanged between the members of the committee, and the chairman was rather puzzled to determine a point from which to start. Several plans were considered.

First.—That the committee should make a series of tests of all meters of different makes and ages. This was discarded because it was considered too big an undertaking.

Second.—That the committee should formulate a plan for, and fix the rules governing tests, which should be made by the gas companies themselves when purchasing meters. This plan was also discarded, it being considered not comprehensive enough and because it would not enable the committee to make any definite report at this meeting.

Finally.—It was decided to divide the work of the committee into two parts, one the securing from the gas companies of an expression of opinion on certain phases of the subject, and the other the securing an expression of opinion from the meter manufacturers, these opinions to be incorporated if possible in one general report.

In point of fact, the committee was appointed to take up the subject with the meter manufacturers, but it semed advisable to also secure if possible some opinions from gas companies. The general reason for the appointment of the committee seems to rest in the main on certain general statements which for the sake of a clearer understanding the committee has divided into three heads.

First.—That the present nomenclature of meters is irrational.

Second.—That there is no rational relationship between the capacities of various sizes of meters as now made.

Third.—That meter manufacturing has been and is standing still, and that meter manufacturers are not seeking to improve their goods.

To obtain if possible the opinion of the gas companies, a series of questions was prepared and sent out to about 300 prominent gas men and gas companies. It is to be regretted that some of the gas men who are known to be well posted on meters and who are best equipped with knowledge on the subject, did not favor us with replies. Some well-known gas men contributed, however, and enough answers were received to reasonably assume that they represent the average knowledge and opinion of the gas men. It was considered best not to incorporate all of these questions and answers in our report, for the reason that they would unnecessarily encumber it and because, in some cases, the contributors would object to having their names mentioned. Again, some of the answers were undoubtedly made in haste, and others contained errors that might subject the authors to ridicule.

Appended to this report will be found a partial list of the questions and some of the representative answers, and the committee begs to present some conclusions which they have come to as a result of their investigations.

After a careful consideration one matter was purposely omitted, that of the relation the price of meters bears to their actual capacity, this being regarded as a matter for consideration between the meter manufacturer and the purchaser of meters.

Rating.—Taking up, first, the proposition that the present nomenclature of meters is not rational, the committee finds that practically all answers received from gas companies agree that the present nomenclature of meters is rather misleading and there seems to be a desire to have indicated, either by name or on the meter the capacity of the meter in cubic feet per hour under standard conditions.

It will be observed from a study of the answers received to the questions sent out that some of these answers contemplate new sizes of meters, which would mean almost a complete revolution in our understanding of the meter and the manufacture of it. Makers would be obliged to discard a large amount of expensive machinery and a great deal of confusion would undoubtedly ensue.

Even should we consider this expense as justifiable, or the confusion worth bearing, it is not likely that gas companies would throw away the meters now in use and purchase new ones, and it would be many years before the new sizes would supersede the old, or this confusion end. It is obvious, therefore, that should a system of rating be recommended that could not be applied to meters now in use, it would be of no value, and would for this reason surely fail to be accepted.

It is fair to say that the present nomenclature of meters dates back nearly, if not quite, to the beginning of the gas business and it has, therefore, the merit of being time-honored, but the conditions under which meters are used to-day are so different from what they were when meters first came into use that, so far as the name is taken to indicate the capacity, it may be time the name was changed. It should not be overlooked, however, that the established and legal proving rate for meters in many states is six times in cubic feet the number of light the meter is called and that for this reason, if no other, it may be inadvisable to abandon entirely the present names.

Several suggestions have been offered as solutions of this problem and we call attention especially to a plan suggested by one of the members of this committee, a nomenclature that could be applied to meters now in use. This suggested plan will be found appended hereto.

To sum up, it seems to the committee that, while it may be desirable to add a further name to the meter more indicative of its capacity under present conditions, yet it does not feel warranted in recommending the entire abandonment of the present nomenclature.

Capacity.—Taking up the second head, that there is no rational relation between the capacities of the various sizes of meters, the committee finds that there is a considerable difference of opinion on this subject.

There seems to be a general impression on the part of many purchasers of meters that no rational relation between sizes exists and that there is no rational relation between meters of the same sizes, but made by different makers.

This opinion seems to be founded on the results of tests made at various times and under varying conditions, but so far as the committee can judge from the tests brought to their attention, these results are of comparatively little value because they were not made under uniform conditions nor with new meters, but oftener with old meters evidently in need of repairs, or with meters repaired in a manner that could not be depended upon to give accurate comparative results.

As a rule, the entire contention of the purchaser that no rational relation exists, is based on the amount of gas the meters will pass under varying differential pressures.

The meter manufacturer looks at the question from a somewhat different standpoint, which is that the capacity of the meter is the product of the capacity per revolution multiplied by a desirable and economic number of revolutions per hour, therefore, in looking for an existing ratio, or determining a future one, the capacity per revolution must first be taken into consideration.

In the table following we give the capacity per revolution of four well-known makes of meters.

An examination of these figures shows the 3-light and 5-light sizes to be rather out of proportion to the other sizes and this may be accounted for by the fact that these sizes are much more popular and competition has tended to increase the capacity. The 5-light meter in particular is used so much in excess of other sizes that it almost stands in a class by itself. Outside of these sizes the list shows that the sizes vary about as the name.

Size. No. Lights.	Cubic Feet per Revolution Capacity.			
	No. 1.	No. 2.	No. 3.	No. 4.
3	0.111	0.111	0.111	0.125
5	0.166	0.166	0.166	0.166
10	0.277	0.277	0.277	0.25
20	0.50	0.50	0.50	0.50
30	0.769	0.833	0.833	0.833
45	1.25	.....	1.111	1.25
60	1.66	1.66	2.00	1.66
80	2.22	2.50	....	2.50
100	2.85	2.85	2.85	2.85

So far as capacity per revolution is concerned it will be seen that considerable uniformity exists between the meters of different makes, attention being again called to the popular 5-light size, which is alike in these four makes, and this uniformity extends to meters of almost all makes.

If it is admitted that the capacity per revolution is the first and basic factor to be determined in calculating the capacity of a meter, it must then be admitted also that the sizes bear a fairly rational relation to each other, and that there is a rational relation between sizes of different makes.

As to the second factor in the problem—that is, the desirable and economic number of revolutions per hour, the committee has obtained from various manufacturers the results of tests made on new meters, but these tests, like those made for volumetric capacity by gas companies, have been made under such varying conditions as to have little value for comparative purposes. As an instance of these varying conditions might be mentioned that several tests were made with air and a correction made to gas, the percentage of correction not always being the same. Some were made with gas of unknown or different specific gravity, and some with connection pipes of insufficient size to care for the full capacity of the large meters.

Some deductions might be made from such figures, but the committee preferred not to give figures unless they could be relied upon and were known to be fair to the different makers.

To sum up, the committee believes that this subject should be looked into further and that manufacturers be given an opportunity to have tests made under uniform conditions.

Improvements.—Taking up the third heading, that meter manufacturing has been and is standing still, and that the meter manufacturers are not seeking to improve their goods.

This seems to the committee to be rather a broad statement, still in the answers received to questions sent out there seems to be quite a tendency to believe that meters can be materially improved, and various suggestions are made in regard to particular points.

The present form of dry meter has been in use for many years. It is, indeed, a remarkable fact that the meter as first perfected in the early years of the gas business was so well adapted to the purpose of measuring gas to the consumer that meters made on this principle have continued to be standard to this day. Modifications of form of course have been made, but that the meter has steadily improved in quality must be true, for it is a certain fact that meters made of a quality that obtained a decade ago would not be accepted by large buyers, or scarcely find a market except in remote districts.

The committee takes for granted, therefore, that when no improvement is claimed, no improvement in detail is meant. Some of the improvements suggested are already in use, some have been tried, and, while possibly of merit, have not found an acceptance on the part of the purchaser. Some have not been tried because there seemed to be no demand, and some because no satisfactory device or method of application has been found.

Sundry suggestions will be found in the answers to questions, but the committee has not had the time or opportunity to obtain any information pertinent to the subject.

The committee believes, however, that as a result of its investigation it can be said that meter manufacturing is not standing still and that the manufacturers are seeking earnestly to improve their goods, only hesitating before radical changes to be sure that there is an undoubted and general demand.

Summary: We beg to report that we have tried in the limited time and with such opportunities as we have had at our disposal to carry out the evident object of our appointment.

If this report seems somewhat inconclusive it is because the subject is a large one, affecting many interests. We believe, however, that if the purchasers of gas meters were all or reasonably all in accord as to what they desired the meter manufacturer to do either as to changing the nomenclature, or, to a reasonable extent, the conditions of manufacture, they would accede to it and co-operate in every way possible, especially if it could be shown that desired change could be brought about gradually,

And we further believe that if this Association desires to continue this subject further, that it should refer it to a representative committee. Respectfully submitted,

CHAS. S. RITTER, Chairman,
R. SHACKLETTE,
DONALD MCDONALD,
Committee.

APPENDIX.

A SUGGESTION BY A MEMBER OF THE COMMITTEE FOR A NEW SYSTEM OF RATING METERS.

A new system of rating should be flexible. That is, it must allow a means of indicating any change in capacity that may occur by changed conditions, such as an improvement in meters. For example, we will assume that the present five-light meter should be called a number ten meter, and that under standard conditions it will pass 100 cubic feet of gas per hour. Change in construction may at some future time cause this meter to pass 130 cubic feet under the same standard conditions. We will then have, relatively, a No. 13 meter (dropping the extra cipher for brevity). Such a system of rating might be easily applied to old meters.

It may seem at first that this system is open to the objection that before long we will have meters of all numbers from five to five hundred. This objection might be overcome by selecting from our present meters the best sizes and using their average capacity as a standard for sizes. Even though it is not to be entirely overcome, it is much more desirable to have meters of a great many different capacities and to know their capacities, than to have a great many meters of a great many different capacities, with a nomenclature that is not only inconsistent, but also misleading. I would suggest, therefore, that meters be rated at their actual capacity, the plan for nomenclature being as follows:

Lights Old No.	Lights New No.	Differential Pressure Loss.	Capacity Cubic Feet per Hour.
3	4	3-10	43
5	7	3-10	77
10	9	3-10	90
20	15	3-10	155
30	19	3-10	191
45	27	3-10	276
60	31	3-10	314
80	38	3-10	379
100	46	3-10	462

This table is submitted only as an example, showing plan of nomenclature. The tests are not accurate, as they were obtained from old meters, and not corrected for temperature and specific gravity.

SELECTED ANSWERS TO QUESTIONS SENT OUT BY THE COMMITTEE.

Question. Do you think that "rated capacity," as now used, should be changed so as to indicate the "actual capacity" of meters at a given differential pressure?

Meters should be rated on the "actual capacity." Gas meters measure volume of gas in cubic feet, and the capacity rating to be consistent should be volumetric, and necessarily to be uniform should be at standard differential pressure, and standard temperature.

I have always been of the opinion that the rated capacity as now used to indicate the output of the meters, was an absurdity, and not indicative of the actual value of the meter at the pressure usually employed, and therefore to this question answer, "Yes, without any question."

The relation of "rated" to "actual" capacity of gas meters is an insolvent problem, and the writer, considering conditions, cannot see what advantage would be gained by substituting a new system.

Even if a basis were established to-day, it might not hold good a few years from now. Meters are being improved all the time, and the capacities increased to as full an extent as good usage would direct.

Meters should be designated by numbers which would indicate their capacity without taxing the gas man's memory.

The "rated capacity" should indicate the "actual capacity," otherwise it means nothing.

Yes, should be rated in cubic feet per hour at a given differential pressure.

I think that the rated capacity of meters is wrong, and that a change should be made.

Yes, if present rated capacity of meters is not correct it should be changed.

If you change the word "should" to "could," I answer, yes.

Question. Would you be willing to change the rating on meters already in use, considering the inconvenience of re-rating them, altering records, familiarizing yourself with the new nomenclature, etc.?

A change will be made in the rating of meters by this Company, and we will be willing to work in unison with the Ohio Gas Light Association.

I would be willing to change from the present method of rating meters, now obsolete by the changed conditions of the gas business.

It would not inconvenience us, nor do I think it would confuse us at all in making the change.

I think all progressive gas companies will welcome it and use it.

If the Ohio Gas Light Association can induce the manufacturers to co-operate, I am sure that the gas companies will fall in line in the course of time. It will undoubtedly be a slow process.

Gas companies should be induced to use a new rating, providing the new rating brought about improvements in the meter design. A mere change in name, bringing no substantial benefit, would be a burden that gas companies would be slow to accept.

The co-operation of all Gas Associations would be necessary.

Note.—The committee would remark in passing that twenty-five gas men, representing companies with an aggregate of over half a million meters in use, reported being willing and desirous of making a change. Four gas men, representing 83,000 meters in use, do not wish to make a change. They did not report, however, that they would not re-rate their meters if a new rating should be adopted. The change would of necessity be gradual, owing to the number of meters already in use. A gas company would hardly be justified in removing all its meters at once to re-rate them, the logical time for making the change being when meters are removed for test and repair. Meter records, however, might be changed at once.

Question. What suggestion can you make for a new system of rating that will indicate the actual capacity of the meter?

A new system of rating would naturally be a numerical system, having a definite relation between the numbers selected and the volumetric capacity. To illustrate—

New Designation. No.	Volumetric Capacity, cu. ft. per hour.
1	100
2	200
3	300
4	400
5	500
6	600
10	1,000

A number designation should be used, which for every increase of one in number would indicate an increase of fifty or one hundred feet in the meter. If meters from now on were to be rated by numbers, all a man would have to do would be to remember that he was to multiply by fifty or one hundred to get the capacity of the meter.

Establish the maximum speed or travel for diaphragm for each size with a fixed differential and initial pressure, and rate the meter accordingly.

I would suggest that meters be stamped by their capacity per hour in feet, and sold on their ability to do it on test by buyer.

I would suggest that a meter that will pass 100 cubic feet per hour at a given differential, should be known as a 100-foot meter.

It seems to me that the only change that would be reasonable would be to put the number of feet per hour on the badge where the number of lights is now put.

Adopt sizes the average of existing sizes, and rate by capacity in cubic feet.

The recognized system of 6 feet per hour for each light marked on the meter, which is now established, and by which the meter is tested for accuracy in cases of disputes as to the accuracy of registration.

Question. What differential pressure should be adopted as a standard to be used in rating capacity? (Consider the tendency toward high pressure, leakage through valves and diaphragms, etc.)

I do not think that the capacity of meters should be rated at more than 0.3 differential pressure. The large use of gas appliances and burners requiring high pressure makes it important that we should deliver gas at the burner under as high pressure as possible. All losses of pressure between the works and the burner should be reduced as low as possible, and we should not allow a large loss in the meters.

With the speed of travel limited to good practice, together with differential pressure not to exceed 0.2, there would be little or no increased demands on valves and diaphragms. The increase in pressure would apply to the case alone.

A differential pressure of 0.5-inch is suggested as a standard in rating volumetric capacity of the meter.

I cannot see why meters cannot be so built that they need not be operated at a differential pressure to exceed 0.2. The lower the differential pressure can be kept the better, and if meters are built with a minimum friction in the working parts and ample area in all gas passages, the meter could be worked to the most economical point regarding speed without subjecting the diaphragms to any great difference in pressure.

This is a little hard to answer, as circumstances might make a very great change in what was best. I would say, however, not more than 0.5-inch, and would also say that the latter part of the question from the word "consider" has no relevancy to the question. Five-tenths.

We would suggest that a differential pressure of 0.5-inch be used in adopting a standard.

Should be determined by a series of careful experiments.

Question. Do you believe, should this Association adopt a standard rating, that meter manufacturers could be induced to use it?

If a majority of the gas men of the country should request it, manufacturers could hardly refuse to adopt it.

Not unless the rest of the gas fraternity adopted it also.

I believe they could if we try hard enough.

I would say that the adoption of a proper standard of rating by the Ohio Gas Light Association would be accepted by meter manufacturers, as I have received a great many comments upon the data contained in last year's Question Box, and I think it is the purpose of gas men generally to give the subject more thought in the future than they have given it in the past, and I think they will see the wisdom of adopting some rational system of rating rather than the present system.

Yes, if rating is ratified by other associations.

Yes, for public opinion could be used to press the gas companies to demand it.

The adoption of a standard rating by an association of gas men would not necessarily influence the acceptance of the same by the meter manufacturers. It would need concerted action by the companies purchasing meters. At the same time, the agitation of the subject by the association would be useful in stimulating the activity of the manufacturers toward improvement in meter design.

Most assuredly.

No, but it would probably be done by united action of all companies.

I do not believe that the adoption by your Association of a standard rating would induce manufacturers to use it, or the adoption by any individual association or company, but I am certain if you took the initiative in the matter you would probably command the assistance of all other gas associations in the United States, and thus compel manufacturers to make the change.

Question. Could gas companies be induced to use a new rating?

I think all progressive gas companies will welcome it and use it.

Yes, most gas companies operate electric stations, and electric meters are rated in quantity of current passed and not in lights capacity.

Gas companies could be induced to use a new rating, provided the new rating brought about improvements in meter design. A mere change in name, bringing no substantial benefits, would be a burden gas companies would be slow to accept.

Most assuredly.

Do not see any reason why they should not, as they would be the gainers.

Assuming that gas companies are managed by intelligent people, I answer, yes.

A majority of gas companies would adopt no rating except that concurred in by manufacturers marking meters accordingly. Some would promise to do anything, and then do anything to the contrary, as evidenced in other matters of a technical nature.

Gradually.

If the Ohio Association can induce the manufacturers to co-operate, I am sure that the gas companies will fall in line in course of time. It will undoubtedly be a slow process.

Question. Would much confusion be the result of a partial adoption only?

I do not see that any confusion whatever would result from its partial adoption. The capacities of the present should be changed slightly, so that our present five-light meter would have a capacity corresponding, we will say, to our No. 2 meter, and the ten-light meter would be given double the capacity of the five-light meter and would correspond to our No. 4 meter.

Yes, adoption should be general by manufacturers and gas companies.

Not if proper systematic methods of recording are used.

A partial adoption of the change in system would necessarily bring out confusion to the destruction of present familiar ratings.

Certainly not. Its application would be limited to a very few people, instead of applied to the masses, as in case of "metric system."

Do not see where any confusion could arise. Should there be any, parties affected would soon conform to the new order of things "per force of circumstances."

Confusion would be the natural result of a partial adoption of any rating system of general interest to the industry.

Question. Is it probable that at some future time the rating we might now adopt will also become obsolete, or meaningless, through change of condition—high pressure, for instance?

No, if a proper one were adopted.

If made good now, would remain for a long time.

I would say that no standard should be adopted that is not based on positive quantity, as gas will probably always be sold by the cubic foot or decimal multiples thereof. I cannot conceive how a rating based on the volume capacity of the meter can become obsolete.

Not likely, as service pressure would not vary greatly.

So long as gas is sold by volumetric standard, would not become obsolete. If gas was sold by weight, or by heat units, some other standard of value would be necessary.

Probably not, unless "high pressure" should be so greatly increased as to make a large difference in volume, under which conditions the base rate would have to be arranged to suit a given pressure. So far, however, regulators are placed on the inlet side of the meter:

I do not regard it as possible that the rating now adopted might become obsolete. If gas meters should be designed and built for high pressure, running, say, to 25 or 100 pounds, there would be a possibility; but I take it that for almost for all time to come, where high pressure is employed, that district governors will regulate the pressure in districts or upon individual meters, as the case may be. The meter, as a fact, will operate always under low pressure.

Conditions naturally change, and a rating suitable for to-day might be lacking to some measures to-morrow.

If we fail to adopt standards because they will in time become obsolete, all progress will cease.

We could not conceive of any change which would result in another change of basis of rating of meters. Our whole system of gas measurement is based on cubic feet per day or per hour. Our unit of measurement being cubic feet, and is becoming more so, since, as stated above, the adoption of the mantle light, wherein the consumption is cubic feet, and unless we would adopt some other measurement than cubic feet, we fail to see where any future change would be effected, unless, as we above state, we go to the metric system, then as a natural consequence our change in rating would be a change following our change in measurement for selling purposes and would fall in very readily, and to our mind far more easily, than if we would continue at the present rating of meters.

Question. Do you regard an ordinary "U" gage sufficiently delicate to measure the differential pressure in making these tests for capacity?

A "U" gage with a diagonal leg would give extremely accurate readings for the purpose.

I would say that reading of the "U" gage is not particularly accurate on a very low pressure, but a gage set on an angle with a very small bore will give considerable travel for a small difference in pressure. Such a gage will be found illustrated in the 1901 Wrinkle Department of the Ohio Gas Light Association.

No tubes should be of the same diameter and scale should be correct. A gage that will slide on tubes, pointing across the scale, should be a part of the instrument.

No, as generally tubes are too small and far apart to hold down the personal error in reading.

The ordinary "U" gage is not sufficiently accurate to measure the differential pressure. An arch gage of the King type, reading the hundredths of an inch, should be employed.

Question. Is it true that the more recently constructed meters have a slightly greater and more uniform capacity than the older ones?

I would say that the tendency is toward an increase in capacity and greater uniformity. Just what the future plans of the meter manufacturers are, I do not know. I do not think they have had very definite plans or have been trying to work to any particular end.

It is true that the more recently constructed meters have a greater capacity than the older meters. For instance, the present three-light meter has a greater capacity than an old five-light meter.

In my experience it is true that the present two-diaphragm meters have less capacity and less uniformity than the former three-diaphragm rotary valve meters.

The established meter manufacturers are making better meters than were made years ago. Yet there has been nothing approaching revolution in the product.

My experience is that the later patterns of meters have a greater capacity than the old patterns.

Decidedly. We know this from a series of tests covering meters of all manufacturers and of many dates, going back as much as 15 years.

Question. Are the capacities of different makes of new meters of same size nearly uniform?

Not nearly so much variation as there was fifteen years ago, light sizes, the capacities of the different makes are practically the same. For larger sizes the differences are quite marked.

My experience is that different makes of meters of the same size are uniform in every respect, there being only one exception —that of the recent meter with glass valves put upon the market, which, for its rated capacity, has a larger output than any other meter I have ever had experience with.

Question. How much is the capacity of meters of the same size and make affected by such conditions as flexibility of diaphragm, valve friction, solder dropped in channels, stuffing boxes packed too tight, bent working parts, or other unnecessary friction not detected in assembling?

I don't know. New meters are practically uniform.

Reduction of capacity can be any amount, according to the flexibility of diaphragm, valve friction, stoppages, etc.

The difficulties you mention should be determined by test and inspection of the manufacturer before sending the meters out.

The matters here referred to are liable to exist in all constructions, and are supposed to be discovered by inspection and test under fixed conditions.

The capacities of meters, due to the conditions you name, might vary from 20 to 75 per cent. No meter is allowed to leave our shop to be placed without being thoroughly examined and all the defects you mention corrected. In other words, we do not accept the correctness of any meter upon the "say so" of the manufacturer, but satisfy ourselves that it will do all that is claimed, by taking it apart and adjusting all troubles where upon test it shows it is defective in any respect.

Question. What suggestions can you make toward the improvement of meters?

Better tin in bottom.

Make them of stronger and heavier tin.

I think something better than a soldered joint should be made to the spindle driving the valve mechanism. I also think a rigid steel tie of some sort should be made between the outlet and the inlet of the meter, and a better soldered joint should be made to the tin tubes on the side of the meter. This could be done by extending the long-threaded connecting piece so it would be smooth and have a slight taper, extending, say, a distance of two inches down the tube, and the space between the tube and the tail of the connection filled with solder. I also believe there is a field for meters with iron cases, to be used in those places where the setting of the meter is apt to be permanent, and removal is only likely to take place for testing or repairs. A more durable case would lessen the cost of maintenance and many meters would pass through the burning of a building without injury, as often they are subjected to only sufficient heat to melt the soldering joint and permit the heated gases to reach the internal portions of the meter.

Keep all channels and parts of casing away from leather of diaphragm; keep exposed seams away from hidden seams so that when one seam is being soldered up the other is not being melted; as to square meters, do away with valve box and separate the dial from gas chamber as in the round meter.

An inexpensive and reliable attachment to the meter for use in indicating and recording time. and rate of consumption. Straight reading dials. Three-light and five-light meters, with same size nipples for connections, and connections preferably for 1-inch pipe; threaded swivels for iron pipe connections; stronger jointing of the meter connection to the tin pipes on inlet and outlet—with the use of iron pipe for connections to house piping there is much twisting and breaking due to the strain of the connection; raise diaphragm to keep bottom free from rubbing and condensation on bottom plate of meter.

While the improvement of the gas meter will depend primarily upon the manufacturers, the practice of using large meters, if adopted by gas companies, will make necessity of immediate improvement less prominent. Several attempts to construct and market an uncomplicated, cheap and reliable meter have failed in recent years. After all has been said and done, it must be a very satisfactory article that will eventually be a substitute for the present gas meter as constructed.

We have only one suggestion for the time being, that is, a meter that does not require three-fourths of the time necessary to repair in getting at the parts to be repaired, as we think the present form of meter about as inconvenient from this point of view as could be made. Whether or not a radical change would be possible, we are not prepared to state at the present time.

The suggestions which we have been making to the makers for the last two years have been principally in the line of increased diameter of diaphragm casings, decreased travel, increased area of valve ports and channels and harder and stiffer flag arms, links, connections, etc. In this connection would call attention to the meter recently designed by Mr. Harrington, superintendent of meters of the Consolidated Gas Company of New York, doing away with the valve chamber and channels and using the proper portion of the meter for the inlet gas.

Protect your meters by placing a drip on distribution riser to catch condensation flowing back from house pipes. This drip should seal gas supply off before allowing condensation to flow into meter.

Note.—The committee asked a meter manufacturer for an opinion from his standpoint regarding some of the suggestions made above. These opinions are given below:

Straight reading indexes of various sorts have been tried and abandoned. It would seem as though a device that would recommend itself mechanically might be found, but up to this time no really satisfactory device has been brought to the attention of the meter manufacturers.

Iron meter cases. Dry meters in cast iron cases have been on the market for years.

Abolish unnecessary sizes. This will no doubt come in time. As an instance it might be mentioned that one large factory has of late discontinued the manufacture of eighty-light meters.

Keep channels and all parts of case away from diaphragm. This is a mooted question among meter manufacturers, and has been under discussion for years, some well-known makers claiming that a diaphragm that touches the case of the meter is best. Careful experiments are being made with a diaphragm that does not touch, a considerable number of meters with such diaphragms having been made and sent out, and careful record is being kept of them.

Abolish valve box and separate the dial from the gas chamber same as in round meters. This practice obtained in meters for years and was abandoned years ago. Its re-adoption would not be an improvement, but a retrogression.

Same sized nipples for connecting three and five-light meters. There is possibly some demand for this, but it would be a radical step and a better solution may be found in the gradual abandonment of the three-light meter and an increasing use of the five-light. The demand for such a connection is by no means general, and in line with this, attention is called to the very great effort that has been made for years to have the standard meter union adopted, in spite of which nearly one-fifth of the meters made in this country to-day have connections not standard at the desire of the purchasers, showing how difficult it is to have undoubted improvement adopted generally.

Threaded swivels for iron pipe. Standard swivels with regulation pipe thread can be obtained of any meter manufacturer.

Question. Would quick operating valves be practicable?

It is essential that valevs should be clean, and they should be self-cleaning as much as possible. Rotary valves and poppet valves have been tried, but the slide valve has proven the most generally satisfactory.

Never saw such application. Anything which would tend to complicate would be very objectionable.

No, there are too many risks attendant upon the operation of quick opening valves in meter construction, and an element of danger and uncertainty which I do not believe we can afford to take risks on.

We hardly think quick opening valves would be a possible feature, as it would be almost impossible to construct a quick-opening valve that the seat will not be exposed very largely to the different deposits from gas, and the shearing effect to a certain extent would be entirely done away with. We, therefore, think a self-opening valve would put us up against considerable trouble. However, eliminating the above features, we think the quick opening valve the ideal one, but whether practical or not, we rather think not.

Question. Would it be practicable in meter shop practice to adopt a certain standard drop in pressure by which meters should be tested for capacity before leaving shop; assuming, of course, that should the meter not reach this standard the fault would lie in assembling its parts?

I see no reason why meter shops could not work to a standard drop in pressure in building and testing meters. A 2 per cent. variation either way would no doubt be allowable in capacity tests, that is, a meter rated at 100 cubic feet per hour capacity would be acceptable to the gas company if the capacity tests showed from 98 cubic feet to 102 cubic feet per hour.

It is entirely practicable, I should say. All motors are tested under fixed conditions, why not a meter?

I consider it eminently proper that the meters should be brought up to the capacity before being sent out of the shop.

From the meter makers' standpoint there is no necessity for such a question.

I think it would be entirely proper to submit the meters to a fixed flow of gas and reject them if the drop in pressure through the meter is excessive at this predetermined flow, and if the drop in pressure is more than is known that meter can be constructed to give.

We practically do this now in our current practice. We believe that the more progressive meter manufacturers see the trouble ahead, and are not only willing but anxious to make such improvements as they can. One of the largest manufacturers expressed to me a few days since his appreciation of Mr. Harrington's work and said he was very anxious indeed to see any improved construction of this sort adopted.

Would say in meter shop practice is where the standard of drop pressure covering the capacity of meters should be adopted, and reference to it in the gas works should only be to confirm or assure yourselves that you are getting meters to the standard required.

It is not the part of the purchaser to make the meter to the standard, but the builder, and also a part of their responsibility to determine where the fault was if they do not come up to the adopted standard. The standard cited, that of capacity based on five-tenth inch, we think a very safe one for gas companies, and also a very reasonable one for the manufacturer. It may possibly reduce the rating of the present meter very materially, but, even so, you would know what you were getting and feel assured that your meter was capable of doing the work for which you installed it.

So far as the size required, it would be entirely within the judgment of the gas engineer as to what size meter under the new standard he could use for certain work, but at the same time he would know when he selected a meter exactly what work it would do, and would not have to cut and try, or in other words, substitute meters for ones placed on a supposed basis of capacity, such as we have now.

Question. Can you make any other suggestions bearing on the subject?

The only further suggestion that I can make is, that after experimenting on the meters, the results of the experiments be canvassed with the Committee of Meter Manufacturers, which committee will undoubtedly do everything that is possible to standardize and improve the meters.

I think a saving could be made by the use of a very inexpensive volumetric governor on the outlet of the meter to prevent the safe working capacity of the meter from being exceeded. We are undoubtedly subjected to meter depreciation owing to the excessive demands, but whether we could save enough on lost gas or meter repairs to pay for the use of this volumetric regulator, I do not know. We could, however, to advantage, make the point of greatest congestion of the meter at the outlet of the meter, and accomplish almost the same purpose of the volumetric governor. The congestion at this point would greatly lessen the differential pressure to which the meter might be subjected.

I have long been in favor of a direct-reading meter dial.

Should like to see all meters fitted with straight-reading meter dials, so that errors in taking statements could not possibly occur, although they might be taken by inexperienced help.

I have always felt that the use of direct-reading meter dials would greatly reduce the numerous complaints of consumers, due to the lack of ability on their part to master the reading of the regulation dial, which to the gas man is as simple as noting the time of day. I think also that the change would be of great benefit to the gas companies, as it would do away with the necessity of breaking in new meter readers, and no doubt enable the average meter reader to do his work more rapidly and with absolute accuracy.

Mr. Ritter:—It seems from the answers we received to these questions that the materials for making recommendations were rather meagre. Most of them, as you will notice, are opinions. Of course they are based more or less upon experience; but the committee did not have time to verify the experiences and did not feel as though they should shoulder the responsibility of fathering recommendations without having time to conduct tests themselves. That will account in a way for what may seem to be an unsatisfactory report.

DISCUSSION.

President McIlhenny:—Gentlemen, you have heard the report of the committee, which certainly evidences a great deal of work on the part of the members. Are there any comments?

Mr. Doherty:—Mr. President, I am considerably interested in the report of the committee. I am sorry they did not come to more definite conclusions; but I think the committee deserves the thanks of the Association for the work they have done. I cannot agree with some of the conclusions that they have reached, and my position on this meter question remains unchanged in spite of the report of the committee. Last year we had some questions in the Question Box which were sent to all the meter manufacturers. The only answers we received to the questions were those supplied by the gas companies. There was no attempt made to answer them by the manufacturers of meters. The questions may have been improperly answered, but the fact remains that the meter manufacturers did not attempt to correct these errors, and the impression has gone abroad, and I for one have that impression, that there is no rational relationship between the parts of meters of the same make; nor is there any rational relationship between meters of different makes and of presumably the same size of the same nominal rating. The committee's report would tend to make us believe that at least the information brought out in last year's Question Box must be very carefully considered. It will not do to jump at conclusions. They also tell us that the meter manufacturers are seeking earnestly to improve their goods and that they are not standing still. If I, for one, am included in those who have made the statement that the meter manufacturers are absolutely standing still, I should have qualified that and want to qualify it now, because I am aware of the fact that changes are going on, but the changes do not necessarily mean improvement; and if the meter manufacturers are seeking earnestly to improve their goods it then seems to me that they are not working along rational lines.

I realize, in taking this position, that I know little or nothing about meters. I have simply had my attention called to them as a purchaser, and I am perfectly willing to back down and take off my hat if I am wrong. Mr. Ritter's report gives us the relationship between different meters per revolution in capacity. Now as he does not say what meter manufacturers they are, I do not know whether there is only one manufacturer or whether there are four manufacturers. He says "four well-known makes." They may all be working under the same shop pattern. Just what relationship there is between the various meter manufacturers I do not know; but they have some sort of a close understanding at least, and the meters are probably made from the pattern out of one shop. I doubt if these close relationships have been produced independently, and I am inclined to think they are the result of an understanding existing between these meter manufacturers of a general nature which involves the matter of selling goods to the gas companies. It would appear from this table as though there were a close relationship at least between the meters turned out by these various shops and by the supposed different makers. But the displacement of the diaphragm is not a thing that has ever been in controversy. We are all satisfied that they are about the same sized diaphragm and would be apt to get about the same displacement. There are other parts of the meter, and each part should be considered in conjunction with the other parts of the meter. My experience with meters is that the different parts have no relationship to each other. The gas enters by a tube having a certain area; then it goes through a port hole. The hole and tube may have no relation whatever to each other. Then it goes into a channel which has an entirely different area. If there is any relationship existing between these various parts and areas which the gas passes through I am not clever enough to understand it. It seems to me that there are points in a meter, and I make the statement without any fear of successful contradiction, where the passage of the gas is congested, causing an unnecessary differential pressure on the working parts of the meter, and where the congestion caused by that part could be removed without any expense whatever, or an expense so insignificant that it would not be noticeable or appreciable.

Now, in this table, the committee fails to state whether these meters were passing this amount of gas per revolution with the same fall in pressure and whether we would get the same amount of gas per hour, with the same drop in pressure; and also what variation there would be in the pressure during the revolution and where a flicker would occur.

Near the close of the committee's report they say: "If this Association desires to continue this subject further it should refer to a representative committee." I would like to know what that qualifying word "representative" means.

I want to make my position clear on this subject. I will say that I still hold that there is no rational relationship between the parts of meters and that the rating of meters is not adapted to our present needs; that the meter as constructed could be improved without any serious expense to the manufacturer and that the design of the meter would not lead an unprejudiced engineer to believe that it was properly designed, but rather that it has been the result of a little change here and a little change there. If I am wrong about this I am only too glad to apologize. That is my position; and my position is that if the meter manufacturers are earnestly seeking to improve their product they are not going at it in the way it would be done in any ordinary engineering office.

MR. DONALD McDONALD, Albany New York:—I want to say on behalf of the committee in regard to Mr. Doherty's criticism about the table that the committee considered, in deference to the time-honored rule of gas associations, not to divulge the name of the manufacturer, as it might be considered in the nature of an advertisement, we preferred to number these different makes of meters. They were obtained without any collusion. On behalf of the committee I will say that they are the figures submitted by the various manufacturers, so far as I was able to get the information from them. The tables were received by the committee from them and they are published exactly as I received them and were given to Mr. Ritter and Mr. Shacklette exactly as they came to me. We selected from these tables the capacity that seemed to offer the widest variation and therefore covering the greatest average results. There was no collusion about it that I know of.

MR. DOTY:—Mr. President and Gentlemen, I want to say that I am in hearty sympathy with the work of the committee, and that the committee is to be congratulated upon the work it has done. It is no easy matter to reconcile differences of opinion that may exist regarding the meters of to-day.

Some fifteen years ago I took up the subject of determining the capacities of meters in order to establish in my own mind whether there is a relationship between the so-called rating of gas meters and their actual capacity, and I confess, after fifteen years of study, I still find that there is something to learn about the meter business. It was with the idea of answering the question that was in last year's Question Box, "What is the capacity of a gas meter?" that I made some experiments in Denver during the past winter. The results of these experiments I have with me, and even with those it is difficult to draw a conclusion. So that to attempt to answer the question to-day, "What is the capacity of a gas meter?" still presents difficulties.

I obtained a table some years since from one of the most prominent meter manufacturers in this country, giving me the rating capacity of the meter, and this table gives the capacity at various differentials. For instance, for 0.5 inch differentials, a 3-light meter is given in this table as having a capacity of 60 feet; 1 inch difference having a capacity of 88 feet; 1.5 inch having a capacity of 106 feet; 2 inches having a capacity of 124 feet. The test dial indicates two feet per revolution, which means 18 revolutions of the diaphragm; that is 9 revolutions per foot, which corresponds to the table which Mr. Ritter has incorporated in the report of the committee, and the figures that Mr. Ritter has given, of course, are easy of verification.

For a 5-light meter 0.5 inch differential gives 80 feet; 1 inch gives 120 feet; 1.5 inch gives 150 feet; 2 inches gives 172 feet. So you see that the question might very naturally be asked, "What is the capacity of the meter?" The table gives the capacity for 10-light sizes, 20-light sizes, 30-light, 45-light, 60-light and so on. To illustrate a wide difference, take the 200-light meter, for instance; its capacity at a 0.5 inch differential gives 920 feet; 1 inch gives 1,300 feet; 1.5 inch gives 1,668 feet; 2 inches gives 1,807 feet. Again, "What is the capacity of the meter?" Now, the Denver experiments were conducted first with the idea of duplicating the results of this table, and we made a series of tests of meters from several well-known meter manufacturers on 0.5, 1, 1.5 and 2 inch differentials and the results agreed reasonably well with the figures given by the manufacturer which were sent to me in 1898. But that did not answer the question, so I made a further series of experiments to determine what would be the limiting capacity of a meter.

Mr. Doherty has pointed out that at a certain differential fluctuation in lights occurs and it seemed to me that this would be the limiting capacity of the meter, and we could work the meter up to the point where the fluctution would begin. Beyond that the meter is overloaded. But the experiments show that even then we are striking unusual conditions. For instance, at Denver with a 3-light meter we found we could work that meter up to 90 feet per hour, but it required a differential of 0.95 inch to do that, the differential being taken between the inlet and outlet openings, and gauges were inserted directly at the opening so that there would be no question of errors in observations. In addition to that, the meter was connected to a bank of lights with piping, and the piping acted as a reservoir, so that we were very far from the actual conditions in the use of the meter in one's house, and the meters were tested with gas so that we could observe the actual working condition. But with this figure—90 feet—before me am I justified in saying that that is the capacity of a 3-light meter working as it does under a differential of 0.95 inch, and can a gas company stand such a differential, and is it safe to use 90 feet in rating the capacity of a 3-light meter? With a 5-light meter we have 152 feet, and that requires a differential of 0.8. With a 10-light meter we have 192 feet, requiring a differential of 0.85 inch. With a 20-light meter we have 315 feet on a 0.6 inch differential. With a 30-light meter we have 406 feet on a 0.75 inch differential. With a 45-light meter we have 623 feet on a 0.65 inch differential. With a 60-light meter we have 750 feet on an 0.8 inch differential. With an 80-light meter we have 804 feet on a 0.55 inch differential. With a 100-light meter we have 955 feet on a 0.6 inch differential; and with a 150-light meter we have 1,366 feet with a 0.7 inch differential. These apparently were the limiting capacities of the meter. Beyond that the meter would not work as a gas meter in service for illuminating uses, because of the fluctuation, so that I revised that table to bring it down to what I would consider a safe working capacity, and for that I said that the 3-light meter has a capacity of 65 feet with a differential of 6-10. A 5-light meter has a capacity of 130 feet with a differential of 6-10. Understand, gentlemen, I am not recommending a 6-10 differential for the distribution of gas, but I am simply reporting the facts. The 10-light meter has a capacity of 167 feet with a differential of 7-10. The 20-light meter has a capacity of 315 feet with a differential of 6-10. The 30-light meter has a capacity of 406 feet with a differential of 7½-10. The 45-light meter has a capacity of 559 feet with a differential of 5½-10. The 60-light meter has a capacity of 600 feet with a 6-10 differential. The 80-light meter has a capacity of 733 feet with a differential of 4½-10. The 100-light meter has a capacity of 800 feet with a differential of 5-10, and 150-light meter has a capacity of 1,306 feet with a differential of 5-10. That was for one type of meter. For another type of meter we found other figures. For instance, the 3-light meter will pass 60 feet, and a 5-light 80 feet, and a 10-light 115 feet and so on. As a result of combining these two manufactures I finally evolved this table: That a 3-light meter possessed a working capacity of 75 feet and required a differential of 6-10; a 5-light meter had a capacity of 125 feet with a differential of 6-10; a 10-light meter had a capacity of 180 feet with a differential of 7½-10; a 20-light meter had a capacity of 300 feet with a differential of 7-10; a 30-light meter had a capacity of 450 feet with a differential of 7½-10; a 45-light meter had a capacity of 545 feet with a differential of 7½-10; a 60-light meter had a capacity of 690 feet with a differential of 6½-10; an 80-light meter had a capacity of 709 feet with a differential of 8-10; a 100-light meter had a capacity of 967 feet with a differential of 6½-10; a 150-light meter had a capacity of 1,350 feet with a 7-10 differential; a 200-light meter had a capacity of 1,500 feet at a 7-10 differential.

The meter manufacturers will know from their experience how this final Denver table agrees with their experience. Whether they will want to ultimately take this table and say that is the capacity of the meter or not I am not prepared to say, but I would be sorry if they would do that, because the differential required to drive that meter is very high. But if they will reduce that differential so that it would bring it down to within reasonable limits for the gas company, perhaps there is something to be gained by us. For instance, if they could give us a capacity of 125 feet for a 5-light meter with a differential of 0.3 instead of 0.6, by changing their present design with very little cost to themselves, by changing the area of the openings and having openings made more nearly uniform and endeavor to establish the relationship, which should exist between the various openings, certainly the work of the committee will have been of very great benefit to the gas companies.

I then endeavored to plot curves showing the relationshsip between cost and capacity. The committee apparently steered clear of that proposition, just exactly for what reason I do not know. If no names are mentioned for the different manufacturers there can be no harm in establishing the fact. If the costs increase uniformly with the capacities, then the relationship between the cost and capacity would be a straight line. For instance, if they gave us a 100 foot capacity for $5, and 200 foot for $10, and a 300 foot for $15, then the relationship would be exact. That is, it would be a straight line relationship. Of course, it may be possible in designing meters to give us greatly increased capacities in the larger sizes at lower cost. Whether that is so or not is a question that the manufacturers know better than I do. I presume, however, the fact is that they manufacture more smaller meters and so are enabled to work their patterns to better advantage than in making few larger sized meters. Perhaps they will give us a straight line diagram. If so, we have gained something there. The line, however, is not a straight line. The costs decrease very uniformly in most of these tests from a 3-light to a 30-light meter. It seems for a 30-light meter the gas company gets the most for its money. Just why that should be so I do not know, but the diagram shows pretty uniformly a decrease in cost for equivalent capacity from a 3-light meter to a 30-light meter. Then it begins to go up rather gradually to a 60-light meter, but an 80-light meter seems to have no reason for existence. The 80-light meter is a burden that the manufacturer should never saddle on a gas company. That is one meter that is out of place, and why that meter should be constructed I do not know. Our table shows the capacity of a 60-light meter to be 600 feet with a differential of 0.65 inch, and an 80-light meter shows a capacity of 709 feet, with a differential of 0.8. With the same differential as in the 60-light meter it would have a capacity less than the capacity of a 60-light meter. But as you know 80-light meters are manufactured and the price of the 80-light meter is given in their tables showing the costs. That is one thing that should be eliminated. The 80-light meter has no reason that I can now discover for its existence. Undoubtedly the manufacturers will take issue with me and say there is reason for the 80-light meter, but if there is I do not know it. I have also plotted curves of various kinds, showing the speed of rotation of the meters per hour and it gives an irregular line, just as Mr. Ritter's tables do, and shows that the larger meter rotates very much less rapidly and the capacity per revolution, of course, changes with the size of the meter. But it is a peculiar curve. It has irregularities which would bear out Mr. Doherty's statement that perhaps the meter business is not quite on a rational basis yet, and that there is subject matter for a good paper still on the question of meters.

As most of you gentlemen know, I have devoted a great deal of time to the study of meters, and have written a number of communications, and I presented a paper on meter testing at the Michigan Gas Association some years since. As the result of my observation I have made a few notes as to the conditions which a good meter should fulfill. The first condition is:

1. *Accuracy.*—I am prepared to state from my experience that a gas meter can be depended on for accuracy. The gas meter is a wonderful measuring machine and is accurate.

2. *Permanency* of its accuracy of registration. On this point there seems to be very wide variation, and just why there should be is difficult to state, but the meter manufacturers will probably put the burden upon the gas companies, and they may say it is due to the quality of the gas, or it is the condition under which it is operated that destroys its permanency of accuracy of registration, but that, I hold to be the condition.

3. *Ability to Withstand Severe Temporary Overloads.*—There is no doubt about the fact that meters are required to work overloaded at times, of which we have no knowledge. The meter may be set where we think a 5-light meter is of sufficient capacity, and when additional appliances are put on suddenly the meter is required to work an overloaded capacity. But the meter should do that without permanently destroying its life or without subjecting it to severe strain. In other words, the meter should be constructed so as to satisfactorily provide for the temporary overload. The next condition is:

4. *Ease of Adjustment.*—That is brought out in Mr. Ritter's report. I would hold that to be one of the points which a good meter should fulfill. The next condition is:

5. *Simplicity and Durability.*

6. *Non-liability to Tampering.*—We find that the meter is tampered with in actual practice, and just how a meter can be made so that it is not easy to be tampered with is a question. Iron cases, of course, have advantages, for we do find with the ordinary tin meter, and with the handy soldering iron that meters have been tampered with. The next condition, of course, is:

7. *Friction.*—Just what the friction is, is difficult to explain. Mr. Doherty has pointed out that it is an error in design. That may be true. The manufacturers will know just how to handle the question of friction, but I do hope that they will be able to design a meter that will give us capacities which we now find to be the best working capacities with a great deal less pressure absorbed in driving the meter. Of course, the most important condition, all things being equal and quality being uppermost, is

8. *Cost Shall be Low.*—I am not bidding for the opportunity to write a paper on meters. There are lots of men who are just as well able and just as capable as I am to do justice to the subject, but I do want to say that the literature on the subject of meters is somewhat meager, making it necessary, therefore, for men, as individuals, to rely upon their own experience very

largely. But, that there is room for improvement goes without saying, and the improvement must come from the mutual co-operation of the gas man, who buys the meter, and the meter man, who sells it.

MR. WILLIAM MCDONALD, Albany, New York:—Mr. President, I have in my hand a few remarks that I prepared before I came to this meeting, and after listening to Mr. Doty's remarks I thought that possibly they were not just as appropriate as they might otherwise have been. I want to say here before I proceed with what I have on paper that I almost entirely agree with Mr. Doty in what he has said. He undoubtedly looked into this matter very carefully, and I give him credit for it. My attention has been called to an extract from a letter written by Mr. Doherty to, I belive, the President of the Ohio Gas Light Association. I am also informed that considerable circulation has been given this extract. In this letter Mr. Doherty charges the meter manufacturers generally with being irrational in various ways. To a certain extent, this is undoubtedly true, because it has been said that no man is entirely rational, it only being a matter of degree. My purpose in speaking of this subject is, so far as I can, to say that the writer of this letter is more or less mistaken in the views he takes of the irrationality of meter manufacturers and their methods, and I question whether he has given the subject the careful consideration to which it is entitled. While he does not say so, nor do I think he really meant it, yet the extract referred to indirectly accuses the manufacturer of meters of not giving the gas company what it pays for. He also says that meter manufacturing has practically stood still because the purchasers did not know anything about the conditions which prevailed. Is it not reasonable to suppose, considering the fact that meters have been designated by their present names for many years and by the entire world, that if there had not been some relationship between the name and the size it would have been discovered before? It is not my purpose to go into any technical explanation of meter manufacturing, but to say that probably the meter manufacturer has taken a slightly different view of the rationality of the sizes than has Mr. Doherty, and also, a somewhat different view of the question of improvement. I have been in the business of manufacturing meters over 40 years, and during such portion of those years as I have more or less had charge of their manufacture and sale, I can truthfully say that it has been my earnest and constant endeavor to give the purchaser as good an article as it was possible to produce and at as low a price as was reasonable. To me the principal factors in meter making are to produce a meter accurate in its measurements and capable of registering as large an amount of gas as seemed to be profitable to those using it, and I believe a great deal has been accomplished in this direction, and that the purchaser of gas meters is being given to-day far more for his money than ever before.

In 1866, 5-light meters were being sold at $13 each, net, and other sizes in proportion. They would not pass at a given pressure more than one-half the gas that the present 5-light meter will pass. Since that time the price of meters has been gradually going down until it is now about one-half what it was then, and, especially with the sizes in general use, the capacity at a given pressure has been going up in about the same proportion. Considering these facts, and the general increase of the price of labor and material, especially labor, is it reasonable to suppose that the meter manufacturer has entirely stood still, and that he has not made some effort to give his customer a better value for his money? Regarding the quality of the goods produced, I desire to say that the manufacturer has done a great deal towards producing a meter that is a perfect measure and reasonably durable when given the amount of work to perform that its name indicates. He has succeeded in doing away with what was known as shrunken or fallen-in diaphragms, because of so much difficulty and dispute between the gas company and its customers. He has succeeded in making tight diaphragms and valves, and by careful attention to the metals in the meter he has succeeded in reducing the friction a very considerable amount, and therefore added to its durability. There is comparatively little complaint nowadays about the accuracy of meters, and it is a fact that if you give the meter a moderate amount of work to do, with gas that is reasonably free from foreign substances, you will get accuracy and durability. When the meter goes out of the factory, new, it is accurate and can only remain so if it is fairly used, so the meter manufacturer in his calculations has always taken into consideration the speed at which the meter is to run, and I think the more the question is studied the more you will discover that there is a very rational relation between the speed at which the various sizes of meters should be run and the names they are called. The figures given in the report show this to be true, and also so far as I have been able to obtain them, the figures show a reasonable relation between the size and capacity of meters made by the different manufacturers, all calculated, if you please, on the speed at which the meter ought to run.

There have been scores of inventions made in the meter line. I have personally examined into this business, being constantly on the lookout for something that seems to be a real improvement. Many of the so-called inventions proved to be merely old devices in a new form. Many were ingenious, I might say unnecessarily ingenious, and I think the purchasers of meters should mark down a long score to the meter men for saving him much trouble in not allowing devices to be put on the market, which while ingenious, were of no particular use. In fact, it has always seemed to be exceedingly difficult to find anything new, the merit of which recommended itself to all purchasers. As a sample of this difficulty take the standard meter unions. After 10 years of effort to get gas companies to adopt these unions, meter factories are regularly producing three sizes of 5-light unions.

I do not say that under present and possibly coming conditions the sizes of meters are altogether as rational as they might be, but I do say that when the amount of work that the meter is fairly capable of performing is taken into consideration the price at which it is sold, as compared with the cost of its manufacture, is entirely and altogether rational. As a meter manufacturer I have no desire to stand in the way of the car of progress, nor do I expect to be crushed by its revolving wheels, but I do say, after long experience and the most careful study of all conditions that surround the manufacture of meters, that it will be well to consider carefully before radical changes are made from the present conditions under which meters are made and sold.

MR. DOHERTY:—The letter to which Mr. McDonald refers was written as a private communication to our Secretary, Mr. Jones. At the time of its writing I had no idea that anybody would see it but Mr. Jones. Perhaps it is too bad that that letter has been circulated freely. But there is nothing in that letter that does not express my real convictions. There is such a thing as a man having beliefs, which are so strong that he is no more responsible for those beliefs than he is for the color of his eyes or his hair, and that letter expresses my beliefs.

Now Mr. McDonald takes a position here which I cannot quite follow. I get up and make the statement that no rational relationship exists regarding the parts of meters. Mr. Doty gets up and shows that they do not exist, and then Mr. McDonald gets up and says that he agrees with Mr. Doty, but says that they are entirely rational. If he will elect which position he will take, I will be very glad to meet him on either ground, but I cannot meet him on all of them, inconsistent as they are. I believe that Mr. McDonald is in the position of claiming that his meter, at least, is thoroughly rational. Don't you, Mr. McDonald?

MR. McDONALD:—I think so.

MR. DOHERTY:—All right. Mr. McDonald is mistaken or else I am mistaken. I say it is not. If there is any way of referring this to a proper arbitration board I will take the responsibility of demonstrating to Mr. McDonald that his meter is not rational. I will also take the responsibility of demonstrating to Mr. McDonald that his meter can be improved without material expense to himself. There may be some expense in changing, but if it had been properly designed originally there would have been no expense to him. We have gotten to the point where one is on one side of the fence and the other is on the other side of the fence, and there ought to be some way to demonstrate and determine which of us is right or which of us is wrong, in degree if we are both wrong. I am not here trying to produce a fight with the meter manufacturers, and I am not here trying to sustain any position that I may have erroneously taken. I am here simply looking for the truth. If I can get that from Mr. McDonald or anybody else, I am only too glad to get it, and I would sooner learn in time what is right than to try and maintain a false position. If Mr. McDonald has no other way of suggesting how we can demonstrate which of us is right, I will ask Mr. McDonald to sell me one of each size of his 3, 5, 10, 20, 30 and 45-light meters; to send me whatever meter he wishes, if he makes some meter that is rational and that I have not yet seen—to send me that meter and I will agree to furnish Mr. McDonald with a written statement of some parts which do not bear a rational relationship to other parts. I will try to get Mr. McDonald to say that it is true that the meter is not rational in its parts. But, as I said before, gentlemen, I am here taking a certain position because it is forced upon me by conviction, and if I am wrong I would prefer to learn rather than to maintain an opinion I have expressed, if it is an erroneous one.

Mr. McDonald:—Mr. President, I, of course, regret that Mr. Doherty makes this a personal matter. I do not know that he intends it, but I tried to say in the few brief words I did say, that Mr. Doherty and I look upon this subject from an entirely different point of view. I think he will find that this is in the paper which I read, and I still am of the same opinion that the difficulty between Mr. Doherty and myself on the subject of meters, is that he takes one view of the subject and I take an entirely different one.

My contention is this—and I want to make it clear if I can—that what the meter man puts on his meter to-day is the right thing to put there; that if you use the meter at what he says it is to be used for, you will not have any troubles, such as he complains about. That is to say, we say a 3-light meter is capable of passing and taking care of and enduring 18 feet per hour, and a 5-light meter 30 feet per hour, and a 10-light meter 50 feet per hour, and a 20-light meter 120 feet. And I firmly believe, in putting meters in for use they ought not to be as far as is generally known, required to register gas beyond those amounts that are named for them. Of course, they are made so that they are abundantly able to take care of any unusual temporary demand that may be put upon them, but the idea of running a meter up to as high a speed as possible regardless of the meter manufacturers' statement as to capacity is entirely and altogether wrong. It is pursuing a wrong idea. The meter should be used moderately. If it is used moderately, it is an accurate and durable instrument. If it is used to its greatest and utmost capacity it is not either. It does its work, possibly as well as it can do it, but it does not do it accurately or well, or continuously when run to its utmost capacity.

I might go a step further to say that I do not believe the people who have been considering the meter subject, outside of the meter manufacturers, have taken into consideration the wear and tear on the meter. The moment you put the meter up to a high speed it deteriorates very rapidly, and it will be but a very short time before it becomes inaccurate, and the inaccuracy generally bears against the gas company by reason of the wear and tear on the meter. Now, the meter manufacturer is trying to give the gas company something that measures the gas and that records all the consumer uses, and I contend that this whole matter, advocated by Mr. Doherty, is on a wrong basis from the meter manufacturer's standpoint. It may be that we will be educated differently some day, but we have studied this matter hard. We have given it a great deal of attention, and this attempt to push the amount of gas a meter will pass up to a high volumetric amount, in my opinion, is a great mistake.

MR. DOHERTY:—Mr. Chairman, I do not like to be on the floor all the time, but I am glad now that I know what the capacity of the meter is. I did not know before. As I understood Mr. McDonald we are to multiply the light capacity by 6.

MR. MCDONALD:—That is what the meter says, Mr. Doherty.

MR. DOHERTY:—No; the meter says so many light, and you assume that is 6 cubic feet.

MR. MCDONALD:—Yes, and everything that has been written on this subject and all the data we have shows that that means 6 feet to the light; everybody knows that.

MR. DOHERTY:—Do you agree, Mr. Doty, that it means 6 feet or 5 feet?

MR. DOTY:—I have heard the statement before that Mr. McDonald has made that 6 feet per rated light is the normal capacity of the meter, but I hardly think that Mr. McDonald himself will take that position, because the meter is changing. As Mr. McDonald has said, we are getting more for our money per capacity in the smaller sized meters than we formerly got. In just a moment, Mr. Doherty, I will prepare a table on the basis of a 6-foot capacity per rate of light, and see whether the speed of rotation of the different sized meters will be uniform. I do not think it will be.

MR. DOHERTY:—While you are preparing the table, Mr. Doty, I will go on and say just a word or two. I cannot imagine any better way to increase the life of a meter than as recommended by Mr. McDonald; that is, to set the meter so that it will not be taxed over 6 feet per rated light, unless it would be to leave it in the warehouse. Why we should use a meter so far below a reasonable capacity for the bulk it occupies I do not see, and I do not see why any rule that pertains to other branches of engineering, regarding speed, etc., should not obtain with meter manufacturers in the construction and use of meters. If we can use a dry valve in other branches of engineering at a certain speed, I think that ought to hold good with the meter manufacturer. Mr. McDonald continually refers to the limiting capacity of the meter. Now, I would like to know—and I ask this in good faith, because I do not know now—what the meter manufacturer considers the limiting capacity of a meter. Where is its limit, and what causes that limit? I can conceive of several things that would cause a limit. One would be the differential pressure. Another would be speed of the wearing parts, and from what has been said I must conclude that they are only looking towards the speed of the wearing parts. Now, after they do that, they should build their meters so that the speed which they consider permissible would require the least possible differential pressure on the working parts of the meter. Now, I want to know from Mr. McDonald what limits the capacity and what means they take to keep that differential pressure at its minimum on the wearing parts of the meter?

MR. MCDONALD:—I do not really understand Mr. Doherty's question. I cannot answer it as he puts it. I do not understand what it means.

MR. DOHERTY:—Mr. President, Mr. McDonald has made the statement that you must not drive a meter beyond some certain point. He does not tell us what that point is and he does not tell us what fixes that point. Now, all I want him to do is to tell us what the limiting speed is and what limits it? What limits the capacity of a meter? I want him to tell us that, and then I want him to tell us what means they take for insuring to us the least differential pressure on the working parts of the meter for that limiting speed, whatever it is that he recommends.

MR. MCDONALD:—I will say, Mr. President, that I do not think the meter man looks at it from that point of view at all. I cannot understand entirely what Mr. Doherty is driving at. Each meter of a certain size, in my opinion, is capable of passing about a certain amount of gas. The fact is, that it comes out of the factory very nearly uniform. It will not vary very much. If we were to go into a technical description of meter making, Mr. Doherty knows that the most infinitesimal amount of oil on the valve of a meter will change its volumetric capacity quite a little; that it is subject to all these very small things that sometimes change its volumetric capacity quite materially, and which it would be almost impossible to entirely and altogether overcome. But the meter manufacturer tries to have the meter in a condition when it goes out of his factory that it will do the best work with as little friction as possible. He bears in mind that the gas meter works under the most infinitesimal pressure of almost anything in this world. When you are talking about a 0.1, 0.2 and 0.3 pressure, you are talking about a very slight amount. No science can be pursued to the point where it comes to an end, and any man who gives the subject thought will find that there is a place to which he cannot attain in the matter of exactness, and it is so in meter manufacturing when you come down to 0.1, 0.2 and 0.3 loss of pressure.

MR. DOTY:—Mr. President, just to have it on record I would like to say that I have prepared a table based upon the rate of capacity which Mr. McDonald has given us of 6 cubic feet capacity per rated light. A 3-light meter would have 18 feet capacity on that basis. The revolutions per foot for a 3-light meter are 9.

MR. DONALD McDONALD, Albany, New York:—Eight, Mr. Doty, mostly 8.

MR. DOTY:—I think this table of Mr. Ritter's shows 9.

MR. McDONALD:—It should be 8.

MR. DOTY:—It makes your case so much worse.

MR. McDONALD:—All right—it is 8.

MR. DOTY:—I will now read the revolutions; remembering that 6 feet is given as the rated capacity of a meter the revolutions per hour are as follows:

Rated Number lights.	Revolutions per cubic foot.	Revolutions per hour.
3	9.0	162
5	6.0	180
10	3.6	216
20	2.0	240
30	1.4	252
45	0.9	243
60	0.7	252
80	0.4	192
100	0.35	215
150	0.25	225
200	0.20	240

You will note, gentlemen, the variation is from 162 revolutions per hour for a 3-light meter to 252 revolutions per hour for a 30-light meter or a 60-light meter. The difference is about 90 revolutions per hour, which would make nearly 60 per cent. more revolutions for the 30-light and 60-light meters as compared with the 3-light meter, which is 162 revolutions.

I believe that Mr. McDonald is not doing justice to himself in giving such a capacity rating for 3, 5 and 10-light meters. I know they are well worth a great deal more than 6 feet per rate of light, and Mr. McDonald knows it. So that the old-fashioned rating of 6 feet per rate of light is obsolete.

MR. McDONALD:—It has always been calculated by meter manufacturers that the smaller meters did more work proportionately and were able to do more work proportionately than the larger ones. I think that can be stated without contradiction; that they have almost always allowed that.

MR. DOTY:—Then I again ask, Mr. McDonald, "What is the rate of capacity of a gas meter?"

MR. McDONALD:—I do not know.

MR. DOHERTY:—Mr. Chairman, I think Mr. McDonald ought to more clearly define his position. He keeps saying that the meter manufacturers' position is so-and-so, but he does not tell us what that is.

MR. McDONALD:—I do not know.

MR. DOHERTY:—You are a meter manufacturer and ought to know.

MR. McDONALD:—Oh, yes; but I do not know. I cannot tell you.

MR. DOHERTY:—There is not very much use in carrying on this discussion if you take that view of it.

MR. RITTER:—Before we drop this subject entirely I should like to say that the basic principle upon which a meter should be built is diaphragm displacement and revolutions, but there are a great many influences that contribute to the durability of a meter that are not contained in the meter itself and are not matters of record. I do not know just exactly what all of these influences are, but I should say that the character of the gas is one; the temperature at which it is registered or temperature at the location of the meter, all contribute very largely to the life and durability of the meter. Some tests were made of 100 new meters about three years ago, a regular routine test. One of these meters was found to become non-registering in nine months, having passed only about 15,000 cubic feet of gas. Another one representing the opposite extreme was O. K. 43 months after having passed 185,000 cubic feet of gas. Between these two extremes we found every condition that you can think of almost.

MR. DOHERTY:—Mr. Ritter did not answer my question regarding a "representative" committee to be appointed by this Association to carry this work on further. I do not know what that word means.

MR. RITTER:—I should like to say, Mr. Chairman, that my interpretation of a "representative" committee is a committee that will represent both the meter men and the gas men.

MR. BUTTERWORTH:—That is what this committee did, Mr. Ritter. Aren't you a gas man?

MR. DOHERTY:—Mr. Chairman, my idea is that this work should not be dropped. We have meter men here and we have gas men here. The gas men are perfectly willing to debate this subject. I have been trying to find out what the limiting capacity feature of a meter is. Mr. McDonald is a meter manufacturer, and yet he tells me that he does not know. Now, at the last meeting of the Ohio Gas Light Association certain data were brought out about meters, and that probably provoked me to write the letter that I did, and which Mr. McDonald objects to. The matter was discussed on the floor of the convention. Afterwards criticisms reached my ears from meter manufacturers. Now, this is not anything that I care to carry on in that way. I prefer to come right out in the open and say what I have to say, and I would be only too glad to have the meter manufacturers do the same. You gentlemen have heard the arguments we have had here. I hope you realize the object which prompts those of us who have taken the position that the meter manufacturer was not entirely rational. We are not trying to dodge the issue; we are here reiterating our position, and it seems to me that now is the time, if we are wrong, to have the error of our way pointed out to us, and I am here still trying to find out what is the limiting capacity of other similar mechanisms put out by other manufacturers, in order that I can carry this work of investigation still further. The committee, I hope, will be continued. I do not see but what it is a "representative" committee, and I want to assure the meter manufacturers, as far as I am concerned, that I am not trying to bring any unnecessary criticism upon them, but as a gas man I am simply trying to get the most I can, legitimately, for my money. Not necessarily the most capacity, but when I get a meter having the least differential pressure and having the greatest capacity, it is reasonable to suppose that that meter will carry a portion of that maximum capacity more readily and for a longer period of time without repairs than a meter such as we are getting to-day. The way it is now in many cases, and especially where the instantaneous water-heater is in use, we would be required to put in a 20-light meter to take care of the volume of gas consumed. For instance, in Madison, Wis., an instantaneous water-heater may yield a revenue per year of $3.60, and yet, according to Mr. McDonald's rule of meters, we would have to put in a 20-light meter to take care of that instantaneous water-heater. We cannot afford to do it. We can better afford to stand some repairs on the meter rather than to have that excessive investment. After all the gas business is a business where we have to watch, with the utmost care and scrutiny, our investments. Every one of you will find on a close analysis of your expenses that your fixed expenses are more than your output expenses. Take, for example, interest on investment, depreciation, insurance and things of that sort, and they will exceed your output expenses. But I want to see the committee continued and go into this subject further.

Mr. McDonald:—I hope that Mr. Doherty does not misunderstand me. There is no question but what any meter, especially in the smaller sizes, up to 20 and 30-light, will easily take care of three times the named capacity in a pressure like a water-heater and they are intended to do it, but they are not intended nor calculated to keep that speed up all the time.

Mr. Doherty:—It comes back again, Mr. President, to the question: "What is the capacity of a meter," and can the manufacturers furnish us a safe working table of meter capacities, and have they ever done it?

Mr. Malone:—I would like to ask if the electric meter manufacturers place a limit on the capacity of their meters? I do not think they know.

Mr. Stone:—Mr. President, I cannot answer that question, but it seems to me that it would be better to refer the whole matter to the committee, and let them take up this subject of differences between Mr. Doherty and the gas meter users on the one side and the gas manufacturers on the other. I have no doubt in my mind but what if any improvement can be suggested to the meter manufacturer by which he can increase the capacity of his meter, say anywhere from 25 to 30 per cent., without increasing the cost of manufacture, or without making any radical change in the meter beyond possibly changing some valves, or some minor points in the construction of it--I have no doubt but what the meter manufacturers would be very glad to do it. I think they are honest in their endeavor to give the buyer the best possible value for his money. They possibly do not see where they could make these improvements. On the other hand, the buyer or the man who uses the meter, wants to get just as large a meter—that is, a meter that will register as large a quantity of gas as he can and not wear out. He wants to get that kind of a meter for his money which will best serve his purpose. It occurs to me that it would be better to refer the matter to the committee and let Mr. Doherty take a gas meter and determine where the points of weakness are, if he wishes to do so, and explain to the committee wherein the meter is weak, wherein the design may be improved, thus giving it a longer life and better service, and still register as accurately and as well as it does to-day, and then let the committee take it up with the meter manufacturers, and see what is the reason that they could not improve their meters by making the changes which Mr. Doherty suggests. Let the two get together in that way, and then at the next meeting let the committee report the results of their investigations; let them report what they consider as being a safe investment on the capacity of the different sized meters. I think that would be better, and we could all get at the real facts in that way.

Mr. McDonald:—As a member of this committee I just want to say one word more. I agree with Mr. Stone. At the same time there are two points in all of this discussion which we cannot overlook. The first is, that the committee, after carefully investigating this matter and after conferring among themselves, come to one conclusion on which they all agree. Now, if Mr. Doherty will agree to that perhaps we can begin to make progress, but he has got to agree to it before we go any further. The first proposition is that "the capacity of a meter is the product of the capacity per revolution multiplied by a desirable and economic number of revolutions per hour." Now, the meter manufacturer will tell you exactly what the capacity of a meter revolution is, but he cannot tell you what the desirable and economic number of revolutions per hour is, because conditions in the gas business are continually changing and have been changing for a great many years. They are changing very much more rapidly to-day than they were some years ago. The gas men should first come into honest accord with the meter men in trying to determine what the desirable and economic number of revolutions per hour is, and then the meter men can answer your question as to what the limitation of the meter is. That is where we are. To continue the committee without first arriving at a point from which we may start in attempting to progress in this matter, is, it seems to me, a futile undertaking.

MR. STONE:—It seems to me that Mr. McDonald's point is well taken. We cannot go back of that. It is simply a question of determining the number of revolutions at which the meter can travel safely. That is, the number at which it can travel and not wear out in a reasonable length of time. And also the difference in pressure at which the user of the meter is willing to concede to the manufacturer as being the limit at which it will work. For instance, if we demand a meter at three-tenths differential then let us set the meter at three-tenths, and see to it that it is not required to exceed that. If we think that a meter will travel a given number of revolutions under given conditions, let us arrive at that result and have it so stated. I think a committee would be able to determine such a question, but let us come to some basis whereby we can reach an amicable conclusion in the matter. Let us come to some basis that would be for the benefit of both manufacturer and the user of the meter.

MR. DOHERTY:—I do not know whether Mr. McDonald expected an answer to his statement or not. I would say, Mr. McDonald, that I am simply in the position of one purchaser of meters. I am trying to insist on the committee taking any particular stand one way or the other. I am not attempting to say what position they should take. But as a member of the Association, I feel it right to call attention to certain things that I consider pertinent in meter manufacture and operation. Now, if we were to assume the position that you assume we would have to assume that it is that feature alone which limits the capacity of a meter, and I hold that is not alone the feature that limits the capacity of a meter. There are a great many things that may limit it. You cannot operate a meter to the point where it will cause a flickering of the lights. And that does not necessarily have anything to do with the displacement of your diaphragm. On the other hand, it is unsafe to work a meter at a considerable differential pressure, and that has nothing to do with the displacement of your diaphragm. If you include the valves and include the openings through which the gas must travel you are limited by the point of greatest congestion in your meter regardless of the size of your diaphragm. So that I simply hold that is not the one basic principle by which you should govern the size of the meter. It is governed by many things and that is for the committee to determine. I think they have done some very excellent work, and I would like to see the committee continued. I think it is a "representative" committee. It is a committee representing the purchaser and the manufacturer, and I would move, Mr. Chairman, that the committee be continued, and let the matter be referred back to them for further investigation.

MR. STONE:—I second the motion.

PRESIDENT McILHENNY:—That would seem the proper thing to do. There seems to be two opposite positions here. Both, no doubt, honestly taken, but there ought to be some method of arriving at some definite conclusion. The question of a meter at its top speed may be considered on one side, and on the other side having in mind the longest life and the best use of the meter. I think that about defines the situation. The question is to arrive at the proper point that may be established and adopted in the meter which best serves the purpose for which it is designed and sold and used. As we all know, many new problems have been presented to the gas companies in recent years. New conditions prevail in the use of gas, and consequently in the measurement of gas. The conditions are new on both sides. The committee has done very excellent work in endeavoring to establish a starting point, and they will probably be able to find a satisfactory conclusion to all of these problems.

The motion above made and seconded was then unanimously adopted.

In continuing the proceedings the President said: "We will proceed now with the Question Box. We had expected that the Question Box would be given the entire afternoon, which it deserves, but the Report of the Committee on Uniformity of Gas Meters has taken more time than we anticipated. It gives me a great deal of pleasure to bring the Question Box before you. Mr. Doherty has the floor."

Mr. Doherty:—I doubt if I can do better than to read the preface of the Question Box, and then suggest if there are any questions here that you want to discuss, that they be brought up later, because I doubt if any of you have seen the Question Box, and therefore you cannot tell what you do want to hear discussed. There is more here than we could discuss fully between now and next June. I just want to make a general statement with reference to the Question Box. I intended to have a digest ready for this meeting, but have been unable to prepare it. It was also our plan to send the Question Box out well in advance of the meeting. We started early enough to do that, but the answers to questions which were promised us by February first were not secured. I can appreciate how difficult it is and would like to impress it upon every member of this Association how difficult it is for a Secretary, or any man attempting to get data together, to secure the work in time to be utilized and I would impress upon all contributors the necessity for getting all matter in as early as possible. They seem to think the convention is a long way off and they only wake up at the last minute. A great deal of the matter that is included in this Question Box was not and could not be secured in time to send it out in advance. If I have anything to do with the Question Box next year I intend to start, if necessary, in May, to have it in the hands of the members before the convention meets, because we would derive its chief value in that way, both by discussion on the floor and discussion among the members outside of the convention hall. In this Question Box I think there is a great deal of interesting information. No man can read it and not have his mind at least directed to a new line of thought. I have been in the gas business a good many years and in varied sorts of ways, and even the asking of certain questions brings up matters that are to me entirely new, and they often come from men who I know are very new in the business. Yet their viewpoint causes them to ask these questions which are calculated to make any old gas man think.

We have divided our Question Box into various departments, such as manufacture, distribution, etc. Perhaps some better arrangement can be suggested. This year we have three indexes. The first index is an index to the contributors of answers. It shows the men answering the questions, who are then designated by a number, and the questions to which they have furnished answers are indicated by the number of questions following their

E. H. Jenkins—1899.
B. P. Holmes—1899.
Henry L. Doherty—1902.
W. C. Boyle—1898.
Charles H. Welch—1893

names and addresses. The second index is an index to the questions, and following the questions are the page numbers; and the contributors are designated by their number which corresponds with the number in the first index. The third index is a subject index; so if it is desired to see whether the Question Box touches upon any particular subject the subject index can be looked at first and that will show the number of the question and the page on which it will be found.

If there is anything that I could say at this time which would give this Question Box better support from the members of the Ohio Gas Light Association and the members of the fraternity I would like to say that thing. The only trouble is I do not know what to say and I do not know how to say it; but I have probably hundreds of letters urging continuation and the expansion of the Question Box idea. Some of them have come from abroad. One particularly was in a foreign language and I had to have the letter translated to see what it said. Now with the number of people asking to have it continued and asking to have the idea expanded upon if that is possible, in justice to them, if for no other reason, it ought not to be dropped. If it is good enough to carry on, it is good enough to carry on well. It is not within the providence of your editor to carry on this work except with the co-operation of a great many men. We can only do the planning, do the actual work of editing and work of that character. The success of the Question Box depends upon your co-operation, and co-operation is valuable to the degree to which it extends, and becomes more and more valuable the more extensive it is, even in greater ratio than the exact proportion of men contributing. That is all I have to say, Mr. Chairman. If any one has any criticisms or suggestions I would be very glad to hear them.

PRESIDENT McILHENNY:—There can be no real criticism of such admirable work as this, and I think it is only fair to say that Mr. Doherty has furnished a very valuable contribution in the annals of gas literature. He has performed an inestimable service for the Ohio Gas Light Association.

MR. DOTY:—Mr. President, I simply desire to call attention to a fact which must be most encouraging to the editor of the Question Box and also to the Ohio Gas Light Association. That there are no less than 149 separate names mentioned as contributors besides a few modest men who sign their names "anonymous." It seems to me this is a marvelous awakening of interest and certainly a magnificent testimonial to the work of the Ohio Gas Light Association. I think when this work becomes better known the men who are in the gas industry in this country and elsewhere will consider it a privilege to have their names inserted in what might be called the Roll of Honor in the Ohio Gas Light Association. Certainly the work is marvelous.

MR. DOHERTY:—I had hoped to have a digest of the Question Box prepared so that we might discuss it easily in that way.

MR. DOTY:—My friend, Mr. Butterworth, is quite a joker, and he has just expressed the hope that Mr. Doherty will not "die just yet."

MR. DOHERTY:—I feel very much complimented, Mr. Chairman, but I fear there are others who might have the opposite wish.

QUESTION BOX.

EDITED BY HENRY L. DOHERTY.

Introduction.

After another year's experience as editor of the Question Box, I am less certain of its value than I was a year ago. I have received many criticisms, compliments, suggestions and comments regarding its value, the methods employed and changes which should be made. This year's Question Box will contain approximately double the number of contributors and double the number of contributed answers.

Certain information to contributors of questions and answers can be best offered here as a means of guidance for next year's contributions. The questions asked should be as practical as possible. They should also be as definite as possible and cover all essential information required by those who might be induced to attempt to answer. The questions should cover, *first,* any information desired, *second,* questions intended to expose popular error, and, *third,* questions for the purpose of introducing new knowledge not of sufficient extent or importance for the production of a paper.

Those answering questions should express something more than an assertion and, wherever possible, should give the reasons for their answers in a way that could be understood by any reader whether possessing an extensive education or not, or by the newest man in the gas business. The answers should be as brief and concise as possible, in fact, as brief and concise as a cablegram, but simplicity and clearness are more desirable than brevity. If the question asked does not give all necessary data for its answer, assume the most natural conditions, state the premises you have assumed and answer on that basis. The answer can generally be applied by the person wanting the information, and is very apt to prove of value to others even if not valuable to the questioner.

It is sometimes the critic who contributes the most improvement to a movemnt of this sort, and therefore criticisms are always welcome, but they should be offered in good faith and not without consideration. Some of the criticisms have been so marked as to leave the impression that the critic had a grievance against the Ohio Gas Light Association for starting this movement and a particular grievance against the editor for lack of sagacity and industry. To the following general criticisms I wish to make definite answer:

(1) Many questions are ambiguous and indefinite.

(2) The questions are not new and their answers can be found in other published gas literature.

(3) Questions are not properly answered and should contain all of the writer's reasons for his answer.

(4) Many questions are wrongly answered and are liable to lead the unknowing ones astray.

(5) The answers to questions should receive the stamp of approval of the Association.

(6) Questions should be collected before the convention meets and answered on the floor.

There is some merit in some of these criticisms, but many of the criticisms and suggestions for betterment are absolutely improper and are the result of a load being shot off out of a gun having a hair trigger.

The first criticism, that "many questions are indefinite and ambiguous," is certainly correct, but the questions are often asked by men who do not know how to put the question, one does not know exactly what they want to get at, and any suggestion for a more definite question is apt to cause its withdrawal. The ambiguity of questions seems to be almost unavoidable. The plainest sort of a question will sometimes be interpreted by some of the contributors of answers in a way entirely foreign to the understanding of the question by its author or by the editor.

Many of the questions which appear the most obscure are asked by capable and competent engineers, and are often put in a form which shows some thought in preparation, although it leaves opportunity for doubt regarding the information wanted.

The second criticism, that the questions are not new and their answers can be found in other gas literature, is also a true criticism, if it is a criticism. The fact that the question is asked would indicate that this knowledge was not general, or that perhaps, as the question is answered in other gas literature, someone may consider the answer an improper one, or he does not fully understand it, or for some reason is not fully satisfied with it. Many answers have been received ridiculing certain questions. One young engineer orally criticised a certain question which upon investigation I found had been asked by his chief engineer, who is a man he greatly admires. Some of the questions are not as foolish as they look, and are not asked by inexperienced or ignorant men.

The third criticism, that the questions are not properly answered and should contain all of the writer's reasons for his answer, is a bit too sweeping to be true. It, however, would be desirable to know the reasons for certain answers and the editor has attempted to secure these in many cases for this year's publication. To the critics who have made this their most prominent criticism, I wish to say that it is not an easy matter to get any answers whatever, and the editor is very thankful for any answers sent him and is sorry that others did not contribute incomplete answers rather than make no contribution at all.

Regarding the fourth criticism, that many questions are wrongly answered and are liable to lead the unknowing ones astray, I am inclined to think that it is partially a meritorious criticism. The editor professes his inability to correct all of these errors, and it would seem rather presumptuous for him to attempt to censor all the answers offered. The questions may be erroneously answered, they may be incompletely answered, but at least a record is furnished of names and addresses of men with whom correspondence can be opened for further information or for their reasons for the answer they give.

The fifth criticism, that the answers to questions should receive the stamp of approval of the Association, I do not think is a proper one. I do not see that the Association can stamp these answers with their approval, nor do I think that an assemblage of men would have any greater wisdom than these same men have in their own offices. My own belief is that written discussion, which need only be offered after mature thought, is of greater value than impromptu discussion on the floor of a convention hall.

The sixth criticism, that questions should be collected before the convention and answered on the floor, is absolutely impracticable. A mailing list of over 1,600 names has been used to collect the questions and answers published. How could this same information be obtained from say 300 men assembled in a convention, with their time limited and not many more than 100 in the room at any one time? Those making this criticism do not appreciate the enormous expense of a convention and the limited time at the disposal of those attending it. I think it is safe to assume that the traveling expenses and hotel bills of each delegate are not less than $50 on the average. Assume that 300 attend the convention and the expense is $15,000. If they put in five hours each day at the convention hall for two and a half days, their time is worth about $20 a minute and can be more profitably employed if answers to these questions are solicited in advance.

Suggestions for improvements have been few and indefinite. Compliments have been more numerous than criticisms, and to those who have spoken a word of encouragement I would say that I think I can assure them that they have helped out the good work in counteracting the depressing effect of the indifference shown by others.

I do not think the gas men of the country appreciate the work, worry and expense of this undertaking, or they would accord it greater support. The Question Box in its present form is not perfect and never will be, but it is hoped that improvement will continue. It, however, should cause every reader to do some serious thinking and should inspire study and investigation on the part of some. It offers a means of locating valuable engineering data and also bring out talent not heretofore known or associated with any of the gas associations. It is bound to expose many popular errors and secure their correction, and will suggest material for Association programs and investigation and research work. It offers an avenue for the information possessed by one to be made common to all, and matters of insufficient importance for the creation of a paper may find a suitable outlet through the Question Box. It offers an opportunity for every man in the gas business to offer some contribution for the good of the fraternity, and by giving an opportunity for the contributions to be prepared in advance, mature consideration and judgment can be applied. It should prove of value to every man having time for research and investigation work, to gas publications and to students, if for no other reason than the many suggestions which it contains.

Every reader of this publication is sincerely requested to offer in detail, *first,* his criticisms; *second,* his suggestions; *third,* methods which occur to him for its improvement, and *fourth,* an estimation of its value and how this value may be increased. It is also desired to know how a more general participation may be secured and particularly from those best able to contribute. The Question Box is a sort of a popular institution, and I fear some of our ablest men consider it beneath their dignity to lend their assistance.

The expenses of the publication have this year been borne by advertisers. The expenditure for the postage and stationery alone in this work is considerable, and beyond the means of the Association.

Either individual members of the Association or advertisers must bear these expenses. The book should prove a good medium for advertising, nor should its value, in any other respect, be lessened thereby. An invitation to advertise in the publication brought prompt and almost unanimous favorable responses.

In closing, I wish to explain, not by the way of apology, but in justice to the plan, that the editor has been extremely busy and has been unable to devote the proper amount of time demanded by the work, having spent fully three-quarters of his time during the period of its preparation in cities other than the one to which his mail was addressed.

For valuable assistance rendered, the editor wishes to thank Paul Doty, M. E. Malone, J. Chas. Andrews and Miss Josephine Baehr, all of the Denver Gas and Electric Company, also Irvin Butterworth, manager of the Detroit City Gas Company.

I can find no adequate words in which to express my thanks to the contributors to this publication. Their contributions are sincerely appreciated and the evidence of their desire to support the movement is still more keenly appreciated.

QUESTIONS.

GAS MANUFACTURE.

No. 1. How much water gas tar can be used in the water gas machine over the fuel bed as a partial means of enriching the gas?

E. C. **White**:—On a 7′ 6″ water gas set using 22 gallons of 28 degree gravity Texas crude oil, we have used (by pumping it over fuel bed in generator) 5 gallons per run. So long as tar lasted we put 17 gallons of above 28 degree oil into carburetter and 5 gallons of tar into generator.

New York & Richmond Gas Company:—References: American Gas Light Journal, December 22, 1902, page 902; December 29, 1902, page 949. Journal of Gas Lighting, December 30, 1902, page 1754.

Chas. F. Cattell:—About 20 per cent. water gas tar. With a six-foot Lowe machine ordinarily using 20 gallons oil per run, making 4,300 to 4,800 cubic feet of gas per run, use 16 gallons oil and 4 gallons tar. Have separate tank and spray for tar.

E. J. Sherwood:—About ¼ of a gallon of tar per thousand cubic feet of gas made can be used, provided a blast pressure of 18 to 20 inches is used on the generator. If a lower pressure of from 12 to 15 inches is used, the fire will not get hot enough to vaporize the tar and still get good results from the steam.

E. M. Osbourne:—Have tried cold water gas tar, and tried it heated and sprayed over top of a Lowe generator, using Pocahontas coke for fuel. Although many efforts were made and many analyses taken, we failed to derive any benefit, while the checkers of the carburetter were quickly clogged up with carbon. This was some years ago. Perhaps someone has had better results.

No. 2. What should be the relation in resistance in the generator, carburetter and superheater of a water gas machine? Assume the drop in pressure is 6″ between the bottom of the grate bars and the top of the generator; what would be a fair drop in pressure for each of the other two shells?

Henry I. Lea:—The differential pressure of carburetter and superheater will, of course, vary in accordance with arrangement of brick and handling of machine. I have found on large machines a differential of four-tenths for the carburetter and of eighteen-tenths for the superheater. On another machine, almost as large, having a capacity of one and one-half million feet, these conditions were almost reversed; the carburetter differential being fifteen-tenths, whereas the superheater threw only five-tenths. With a generator throwing 6 inches differential, a drop of from ½ inch to 1 inch in each of the remaining two shells, would be fair.

E. M. OSBOURNE:—This differs in machines of the same type and apparently built on the same principles. When in good condition the gauges step down like a stairway, varying from 2½" to 4"; generator being 18", carburetter 14", and superheater 10". Condition of checkers in carburetter and superheater, and condition and kind of fuel and clinkers in generator, have much to do in these relations.

ANONYMOUS:—In a modern Lowe setting with bricks clean and spaced say 2 inches apart, the loss of blast pressure in the carburetter bricks should be from 2 to 3 inches, and in the superheater bricks from 3 to 3½ inches. (See also reply to Questions No. 13 and 14).

No. 3. Is it better to alternate the running of a water gas run while making gas, or is it better to make one entire up run and then one entire down run?

WALTER M. BLINKS:—No, according to best authorities.

W. S. BALDWIN:—From experience with two Lowe Improved machines, 10 ft. sets, we find that a continuous down run every fourth time is the most successful method.

HENRY I. LEA:—It would strike me that reversing while the run is on would be aiming at a delicacy of operation that our knowledge of conditions of the fuel bed at any moment would not warrant.

J. T. MASON:—One down run in five or six is sufficient, and that should be a complete run, unless the generator fuel is bad and the clinkers get too high. In that case make the down run often enough to keep the clinkers down.

E. M. OSBOURNE:—Experience has developed the fact that it is best usually to make two to three up runs and then a down run. The condition of the generator fire governs the proportion of up and down runs required.

ANONYMOUS:—Mr. W. C. Morris, East River Gas Works, Long Island City, made remarks upon this subject in a paper read before the American Gas Light Association at its meeting of 1903. Consult this paper.

No. 4. Is there any advantage in carrying a high boiler pressure for water gas making, and wherein does this advantage lie?

J. M. COLES:—By carrying a high boiler pressure you deliver a dry high-temperatured steam to the generator, keep the fire in a better condition, lessen the percentage of carbonic acid gas and also make a saving in generator fuel.

C. H. WILLIAMS:—In making water gas, it is advantageous to have as large a number of B. T. U.'s per pound of steam as possible, in order to carry as much heat as possible in with the steam that the run may be prolonged, but steam at 150-pounds gauge only contains seven-tenths of 1 per cent. more B. T. U.'s in total heat per pound, than does steam at 100-pounds gauge, so the increase along this line is not material. Water contained in the steam requires 966 B. T. U.'s for each pound which is converted into steam; consequently, the percentage of water should be kept down. If superheating of the steam could be accomplished economically, this might add to the efficiency of the apparatus. The higher the boiler pressure, the greater the tendency to leakage and losses, and maintenance costs are thereby increased.

E. W. SMITH:—Advantages in carrying high steam pressure —dry steam for fuel gas and even pressure for the oil spray.

CLARENCE S. LOMAX:—There is a decided advantage in carrying a high boiler pressure in water gas making, owing to the fact that it is cheaper to put the lower fraction of the heat necessary for the water gas reaction into the steam in the boiler, and this fraction should be made as large as possible; thus depriving the heated coal or coke in the generator of less heat units per thousand cubic feet of blue gas produced. The higher temperature thus conserved will tend toward a greater and purer make from each blast. The actual advantage may be measured in the difference in heat efficiencies of a blue gas generator and a high pressure steam boiler.

W. S. BALDWIN:—There is a great advantage in carrying a high boiler pressure. When the steam is liberated into the generator, the pressure is lessened and the extra heat in the steam tends to superheat it and we therefore have a dry steam with which to make gas.

FRED H. BECK:—Yes, the higher the pressure the better, as the steam is dryer and will not kill the fire in the bottom of generator as quickly.

CHAS. F. CATTELL:—The only advantage in carrying high boiler pressure is to obtain dry steam. If you superheat your steam, 60 pounds is sufficient.

LEONARD FITZGERALD:—The advantage derived from carrying high boiler pressure in making water gas is that the steam under high pressure is much hotter and dryer and therefore does not reduce the temperature of the fuel bed so quickly. It takes less heat (and therefore less fuel) to "break up" high pressure steam into its elementary gases. The high pressure behind the steam also forces it further through the fuel bed, and prevents the fire from being killed at the beginning of the run.

M. N. LATTA:—The one advantage to be derived from a high boiler pressure is the securing of the dryest possible steam, and the avoidance of condensation and entrained water. There is also a saving of heat-units which must be taken from the generator fire as a complement to the temperature of the steam before "breaking it up" prior to the formation of its respective gases. On this subject see Work of Harris and Dr. Bunte.)

As a disadvantage to this high pressure a greater rapidity, or rate of flow, is secured, causing less diffusion of the steam throughout the carbon body, thereby creating less general and perfect contact between the constituents and the passing off of the steam undecomposed, thereby creating "excess."

HENRY I. LEA:—The advantage in carrying a high steam pressure in water gas making is due to the fact that steam cannot be decomposed below a given temperature, and if the generator fuel must expend part of its energy in doing work which might be done to better advantage in the boiler, the period of gas making must be shortened in proportion. The actual working capacity of the generator is therefore dependent to some considerable extent on the temperature of the steam entering it.

E. M. OSBOURNE:—Yes. It lies in the fact that higher pressure furnishes dryer steam. Dry steam does not kill bottom of fire so quickly, hence less carbonic acid gas is made. Also the quantity at higher pressure is larger. This is more marked where up runs only are made, the dryer steam permitting a longer run without clearing than the lower pressure steam. In practice, however, 100 to 110 pounds pressure is considered sufficiently high and to be about the proper point for economy. When steam drops to 60 or 75 pounds a decided falling off in make is noticeable, and an increase in the carbonic acid gas shown by analysis.

ANONYMOUS:—Practically the only superiority of high pressure over low pressure steam supply for water gas generators, is that it permits the use of smaller piping, and also gives increased steam storage capacity to the boiler. Since, however, steam from the same boiler will be used for engines, etc., for which purposes high pressure steam is far more economical than low pressure, a high pressure is necessary.

EDITOR:—The value of high pressure steam is undoubtedly over-estimated. Steam at atmospheric pressure and 212 degrees contains 1178.6 B. T. U.'s, while steam of 120 pounds boiler pressure contains 1220.4 B. T. U.'s, the higher pressure steam only having 41.8 B. T. U.'s more, or approximately 3½ per cent. more heat. Any practical advantage found in high pressure steam must be due to the presence of less water in the form of water. Superheating the steam at atmospheric pressure, adding less than 100 degrees, would more than compensate for the additional heat contained in the 120 pounds steam which would have a temperature of 350 degrees F., or steam at atmospheric pressure superheated at 312 degrees F. ought to be more desirable and advantageous than 350 degree steam at 120 pounds pressure. It should be more economical to put this heat into steam in some other way than by generating heat in a boiler furnace and transmitting it through the shell of the boiler to the water. I doubt if many boilers in gas works yield an efficiency of 50 per cent.

NO. 5. What is the difference between a regenerative furnace and a recuperative furnace?

E. C. WHITE:—A regenerative furnace is one in which the secondary air only is preheated. A recuperative furnace is one in which both primary and secondary air are preheated.

V. F. DEWEY:—A regenerative furnace is one in which the flow of the waste gases and secondary air alternate in passing through the recuperative flues. I know of no such a furnace in any coal gas plant. All the so-called regenerative furnaces are recuperative.

WALTER M. BLINKS:—Difference in name; the better practice now is to speak of the furnace as regenerative and the heating passages for secondary air as the recuperators.

HENRY I. LEA:—While the terms "regenerative" and "recuperative" are ordinarily considered as synonyms, I believe "regenerative" applies more correctly to that type of furnace in which carbon monoxide is obtained as the result of two or more conversions in body of the fire; while "recuperative" has more properly to do with the transfer of heat from the waste gases to the incoming air.

WALTER THOMAS:—I fail to see any difference. They both utilize the heat of the waste gases after they have left the setting proper.

W. S. BALDWIN:—A regenerative furnace is one in which the air is preheated by passing through a chamber previously heated by means of the waste gases. It is an intermittent process.

A recuperative furnace is one in which the air is preheated by passing through a chamber heated from the outside by means of the waste gases. This is a continuous process.

IRVIN BUTTERWORTH:—There is nothing in the etymology of these words that would prevent their being used interchangeably in describing the two kinds of furnaces, but as I understand it an arbitrary distinction has been made in their meaning for this purpose, "recuperative" being used to designate that class of furnaces in which the incoming air is heated by the outgoing products of combustion, each passing continuously in opposite directions; while the word "regenerative" designates that class of furnaces in which the products of combustion are passed alternately in opposite or different directions, heating in turn the walls of two sets of flues or checker brick chambers through which the incoming air alternately enters.

D. R. RUSSELL:—I believe that there is no technical difference, as one name could be applied to one kind of construction as well as another in my opinion; but custom, at least with reference to gas retort benches, has settled the question by naming a bench where the products of combustion pass through one set of flues continually and the secondary air passes through another set of flues continually, said flues being in close proximity to each other and the air being heated by radiation from the flues containing the waste gases from the bench, a recuperator furnace. To my knowledge, there are no regenerator benches used in the United States. In this construction, the two sets of flues or two chambers are used. A portion of the time the waste gases pass through one chamber, and the air for combustion through another chamber. After a certain period the flues are reversed, changing the air from the flue through which it has been passing to the flue through which the gas has been passing and which has become heated. The waste gases are then taken through the flue formerly used by the air, and which has been cooled down by it, thus again heating it up. This requires a constant changing of the gases and air from flue to flue. Said construction is used in heating furnaces for steel works etc., and they are called regenerator furnaces.

W. A. BAEHR:—A recuperative furnace is one in which the air for combustion is preheated by passing through a flue, or set of flues, without reversal in direction and continuously; the transfer of heat being accomplished through the walls of the flues.

A regenerative furnace is one in which the air for combustion is preheated by passing through a flue, or set of flues, which have been previously heated by the passage of waste gases through them. The transfer of heat is accomplished by the contact of the incoming air with the hot flue. After the flues have been cooled by the incoming air, the same is admitted through another set of flues previously heated by the waste gases, the waste gases then being turned back into the first set of flues for the purpose of reheating them. It is not necessary that any reversal of direction of flow take place, although such is usually the case.

EDITOR:—Some standard nomenclature should be adopted to designate furnaces. The generator adopted by Seimens is not used in bench construction, and our ordinary bench is properly a producer-recuperator furnace.

No. 6. What is the difference between a half-depth bench and a three-quarter-depth bench?

O. B. WEBER:—For benches using five or six retorts the one-half-depth furnace has been found sufficient, obtaining the same economies in fuel and costing less for erection than the full-depth furnaces. On benches of eight, nine and ten retorts the three-quarter-depth furnace must be used to obtain the full benefits of recuperation.

I am now designing benches with ten (10) retorts using pulverized fuel, upon which I have applied for patents. With this mechanical device we shall do away with the old system, using, however, hot air from the secondary air supplies with the blower.

Walter M. Blinks:—A half-depth bench has a fuel bed three feet deep, the bed of a full-depth furnace is from five to six feet deep, and the three-quarter will naturally be the mean between the two.

Walter Thomas:—No difference except in dimensions of furnace. We have full-depth regenerators here and half-depth.

Depth of fuel, full-depth, 72 inches.

Depth of fuel, three-fourth-depth, 54 inches.

Depth of fuel, one-half-depth, 36 inches.

Of course this varies according to the ideas of different engineers. I have erected what was considered full-depth, fuel on 60 inches, but much wider.

V. F. Dewey:—No difference. No such thing as three-fourths-depth bench.

C. H. Williams:—A half-depth bench is one in which only the secondary air passes through a process of recuperation.

A three-quarter-depth is one where the primary air is given a partial process, while the secondary receives its process of recuperation.

W. S. Baldwin:—There should never be such a name as a three-quarter-depth bench. If the primary as well as the secondary air is preheated, then the bench is a full-depth bench. If only the secondary air and not the primary air is preheated, then it is a half-depth bench.

W. A. Baehr:—A half-depth recuperative bench is one in which the secondary air only is preheated.

A three-quarter-depth recuperative bench is one in which either the secondary air only, or both the secondary and primary air are preheated, but there is no clear, distinctive feature to mark such a bench decidedly in a class by itself. It seems to exist only as a slightly deeper recuperator than a half-depth, or a slightly shallower recuperator than a full-depth bench. I regard the term as a very unfortunate one, and it should be eliminated.

The builders who originated the term "three-quarter" depth did so largely because they found in a great many gas works the retort houses were not as high from the cellar floor to the charging floor as their standard full-depth benches called for. These same builders had standard half-depth benches in which that same height was figured much lower than the height found in these old works. The result was that they designed a so-called three-quarter-depth bench, which is distinguished, as previously noted, from the full-depth and half-depth benches merely in height, and as such, there is no clear distinction whatever.

In place of making a distinctive feature in such a bench in the line of some particular point concerning preheating of the air, or something similar, the builders have simply made the distinction by the vertical dimensions from their usual standard plans. The gas profession as a whole cannot countenance such a distinction, in my opinion, and I would say that their so-called three-quarter-depth bench, if the secondary air only is preheated, should properly be called a half-depth bench, and if both the primary and secondary air are preheated, it should properly be called a full-depth bench.

No. 7. What temperature is required to gasify gas oil?

W. E. BARRETT:—In answering this question, I may say in general that gas oil is a composition sometimes fearfully and wonderfully produced, but as such, from Ohio or Pennsylvania fields, of a gravity of about 35° B. (which, by the way, determines very little and means almost nothing as regards the quality of gas oil), reaches the point of complete vaporization at 700° to 750° F.; and Texas gas oil from Beaumont field, showing a gravity of 26° to 28° B., reaches complete vaporization at 650° to 700° F. As I interpret your question, the above temperatures will cover the answer. If the inquiry should mean, at what temperature does gas oil vapor combine with the water gas to become a commercial fixed gas, this is quite another matter. Up to the present, gas oil has been so varied in its composition that it would be almost an impossibility to name a temperature with any degree of certainty that would cover the question.

CLARENCE S. LOMAX:—I have had the best results at about 800° to 825° Centigrade.

FRED H. BECK:—From 2,000° to 2,200° F. are required to thoroughly gasify gas oil.

ANONYMOUS:—Mr. Glasgow, in his paper, "The Practical Efficiency of an Illuminating Gas Setting" (see American Gas Light Proceedings for 1890), gives the temperature of the illuminating gas at the superheater outlet at 1,450 degrees F. This probably represents the maximum temperature at any time attained by the gas, although the brick in the carburetter was probably of considerably higher temperature. These experiments were made on a double superheater Lowe set. Crude oil was used.

No. 8. How can clinkering in a water gas generator be prevented or lessened?

Chas. F. Cattell:—To prevent clinkering, reduce the blast pressure on generator. This, generally speaking, answers the question, but much depends on the kind of coal used and also on the gas maker himself. First, select a good coal that would, after different trials, prove to be tough rather than brittle when exposed to high temperatures; that is, a coal that would stand the blast without slacking or breaking up in the generator. It should appear like big, red-hot stones on top when ready to "coal up." Secondly, in a plant where a machine is not running continuously, it should be gradually worked up to a proper heat before forcing it. Some gas makers are apt to use too much steam, thereby drowning out the fire and making a poor quality of gas, the tendency being to make quantity rather than quality. A great deal of this, of course, condenses again if not properly fixed, increasing the percentage or leakage or shrinkage of holder gas.

Briefly, my experience is, to first work the machine up into good condition for gas making, being careful not to use too much steam; hence, the heats can be maintained and more fixed and better gas turned out, at the same time running with less blast pressure, thereby reducing the formation of clinkers.

J. M. Coles:—By alternating the steam in the middle of each fan the clinker is lessened and more gas is made per run.

Henry I. Lea:—Clinker is ordinarily formed in the water gas generator largely because, in blasting, many inequalities are produced in the fuel bed, some portions becoming much hotter than others. As the air passes more readily through the hottest portion of the fire and the steam through the coldest, these varying temperatures are doubtless encouraged; certain portions of the fire are therefore exposed in temperatures considerably higher than necessary. These troubles are overcome by uniform distribution of the blast under the grate, thus bringing about uniform temperatures and carrying the body of the fire much closer to the grate than is possible with the ordinary blast arrangement. The divided blast, in connection with barring up between clinker periods, renders unnecessary the use of steam for the "rotting" of clinkers.

W. S. BALDWIN:—By the use of coke breeze around the edge of the generator we find that the clinker on the sides of the generator is greatly lessened.

H. L. RICE:—As the formation of clinker is dependent on the nature of the fuel, the blast, steam, and proportion of down runs used therewith, no rule other than thoughtful experiments and application of results observed can be given. The writer has thought that a flux could be used to advantage with such a coke as Toms Creek, which under all conditions furnishes an iron clinker on the bars, but as suitable fuels have been available the experiment has not been made.

E. M. OSBOURNE:—By proper fuel and right management of generators. This done, no clinkers save at bottom should occur. Have cured a so-called bad clinkering generator by placing another operator in charge of machine; this without change of conditions. Too strong a blast after bottom of generator has been cooled for eight or ten minutes by steam has a tendency to cool it; hence lighter blast is followed by increased pressure after being on two or three minutes.

J. S. DIXON:—The most usual method of preventing excessive clinkering in a water gas generator is by the judicious use of steam. As I understand it, the object of up and down runs, or putting the steam alternately above and below the fire, is to keep the fire in good condition by softening up and breaking the clinker which has a tendency to form at the point of extreme heat, which would ordinarily be on top, as the blast is always from the bottom towards the top. High blast pressure also has a tendency to increase the clinker, and as the advantages of high blast pressure are recognized in increasing the make and oil efficiency, the tendency to clinker must be overcome by making more down runs. Another important point is to see that the generators are thoroughly cleaned and all clinkers removed from the side walls of the generators at least once a day. The fuel lost in thoroughly cleaning the generators at least once a day will be more than made up by the increased results obtained in starting out each day with an absolutely clean fire. I am convinced that in many small works where the superintendent is not always on the ground, the matter of thoroughly cleaning the fires does not receive the attention it should.

E. P. GARTLAND:—Clinkering in a water-gas generator can be prevented or lessened by putting a layer of slaked lime or oyster shells on the top of the fire, around the lining of the generator. This should be done once or twice a day.

E. W. SMITH:—By exercising good judgment in use of force draft; also care should be taken in the use of steam under the fuel bed.

ANONYMOUS:—The formation of clinker in the generator is of course greatly increased by undue heating at the fire. It can be prevented by shortening blows to the proper point, and also in the case of "reverse steam" apparatus, by experimentally adjusting the ratio of up and down runs; if bad clinker is found to exist, for instance, at the bottom of the fire, decrease the proportion of down runs.

No. 9. What is the temperature of the gaseous products in the top of the generator during the gas making period?

FRANK LANGWITH:—The following tests were made after cleaning a fire that had been in use for six hours. The period of cleaning was two hours in length. The cleaning was done from the side doors first, and while cleaning from the front door the fire had an opportunity of brightening up under natural draught. At this time, after the generator had been open nearly an hour, the temperature at top of generator was 1,000 degrees.

The following table will show the temperature at various points in the apparatus during the blow and run.

		—First Blow—			—Run—	
Where taken—	**Begin.**	**5 min.**	**8 min.**	**10 min.**	**4 min.**	**8 min.**
Top of Generator..........		1,500°	1,950°	1,950°		
Top of Carburetter..........	1,000°			1,600°	1,400°	1,000°
Sight-cock of Carburetter...	900°			1,400°	1,200°	1,100°
Sight Cock of Superheater..	800°			1,250°	1,100°	1,000°
Top of Superheater........	700°			1,100°	1,000°	900°

During the four runs of eight minutes each with five minute blows, the temperature at top of superheater did not go below 900 degrees, but varied a little, fluctuating between 900 and 1,000 degrees.

V. F. DEWEY:—About 1,600° F.

DONALD DAVIDSON:—1600° to 1610° F.

H. B. Harrop and J. T. Mason:—With two nine-foot-six and two eleven-foot-six sets to choose from, the following tables, compiled in Milwaukee's Third Ward Works, are offered as typical of the temperatures at different points in producing 26 candle gas with this form of apparatus. The readings given are for half-minute intervals, the run lasting 4 minutes and the blast 6:

Top of Generator. Deg. F.	Top of Carburetter. Deg. F.	Outlet of Carburetter. Deg. F.
1791	1886	1470
Air off; steam on.	Air off; steam on.	Air off; steam on.
1823	1742	1494
1769	1605	1494
1697	1481	1486
1652	1382	1474
1616	1283	1462
1589	1202	1449
1571	1130	1436
1535	1058	1423
1526	1031	1409
	Oil off.	
1508	1058	1395
		Oil off.
1499	1089	1389
1490	1117	1393
Air on.	Air on.	Air on.
1472	1184	1395
1481	1263	1409
1526	1337	1423
1535	1422	1440
1571	1573	1452
1607	1688	1478
1661	1623	1513
1715	1922	1540
Air off.	Air off.	Air off.
1755	1868	1526

These readings are best comprehended by plotting on paper and drawing curves. It should be remembered that a pyrometer only approximates the temperature of a highly heated gas in a closed space, the reading found being a resultant of the actual temperature of the gas and of the inner walls of the chamber; there is also a slight "drag" due to the mass of the protecting sheath of the pyrometer.

The temperature in the take-off pipe leading from the superheater to the wash box varied from 1300 degrees to 1700 degrees during the run. The gas at the outlet of the wash box ranged from 176 degrees to 190 degrees.

The readings at different points were not taken at one and the same time and of course the conditions vary somewhat.

ANONYMOUS:—In some experiments made by Drs. Strache and Jahoda (see *London Journal of Gas Lighting,* Jan. 1st, 1901, also *American Gas Light Journal,* Nov. 2nd, 1903, page 689), they found the temperature of the water gas at the top of the fire to vary from 450 degrees F. to 950 degrees F. Their lengths of blow were, however, in some cases as high as 20 minutes, probably giving a very hot fire.

No. 10. At what temperature does carburetted water gas leave the superheater?

V. F. DEWEY:—About 1,600° F.

M. N. LATTA:—Between 15 and 14 hundred degrees F. (depending upon temperature of apparatus.)

E. P. GARTLAND:—Carburetted water gas leaves the superheater at a temperature of about 910° F. This temperature was taken at a point on the off-take pipe two feet from superheater shell.

H. B. HARROP AND J. T. MASON:—See answer to No. 9.

ANONYMOUS:—See reply to question 37.

No. 11. Would not split brick be better for checker work in the carbureter and superheater rather than regular sized brick?

CHAS. F. CATTELL:—Regular sized straight brick, well burned, give the best results in carburetter and superheater.

W. S. BALDWIN:—With split brick we would have twice the heating surface with the same annular space, and could therefore use twice as much oil in our carburetter.

HENRY I. LEA:—This question, it would appear, demands knowledge of the ratio between total volume of gas passage and total volume of brick work; brick volume itself must be taken in connection with surface of brick exposed to the flow of gas, and the whole thing would hinge on the particular oil to be used. As this latter is always variable, it would strike me that the only practical course is that already adopted, under which sufficient brick work is provided to handle the heaviest oils at proper temperature, and provision for the handling of the lighter oils is made by regulating the temperature of the brick work and the rate of the flow of gas.

J. T. Mason:—Split brick might do as well as the regular size brick in the superheater, but would not do at all as well in the carburetter. The fact that the first four or five rows on top of the carburetter get badly broken up by the oil falling on them, would make it impracticable to use split brick. I cannot see as there is anything gained by using them in either place, because though the split bricks are cheaper per thousand than the regular brick, yet more must be used in covering a given area, making the cost in the long run greater for the split back; besides, they would have to be renewed more often than the regular brick.

Below are figures on 100 square feet of area with spacing of two inches.

No. 1 fire brick, 346½.
Split brick, 453.
Cost of No. 1 brick, $7.97.
Cost of split brick, $8.83.

Showing a difference in favor of the regular No. 1 brick of 86c per hundred square feet of area.

E. M. Osbourne:—No. However, in small settings the smaller bricks are better for carburetter, as it insures a better breaking up of the oil and prevents a likelihood of its settling at bottom of carburetter. As these bricks become filled up quickly, they can be removed and new ones replaced. The large bricks in superheater are better, as they last longer, hold heat better, and can be placed far enough apart to insure free passage of the gas, and still contain heat enough and hold it long enough to thoroughly fix the gas. The large machines are generally checkered with full size bricks in both chambers.

Anonymous:—Split brick for checker work would of course give greater heating surface for a given volume of brick than does the ordinary No. 1 brick. "Soap" brick, which is one-half the depth of a No. 1 brick, is sometimes used for this reason. It is probable that either of these two forms of brick is weaker and less durable than the No. 1 brick, and its use not desirable, unless for very special reason.

No. 12. What gas companies now use charging and drawing machinery?

R. B. **Brown**:—Ross machines are or have been in use at the following points:

Boston, New York, Cleveland.

Philadelphia (charging machines only).

Milwaukee, Indianapolis (drawing machines only).

Cincinnati carbonizes all their coal with this type of machine, both charging and discharging.

Bronder machines are or have been in use in this country at the following points:

Consolidated Gas Co. of New York—Charging: Three at West Eighteenth Street works, 2 at East Fourteenth Street works. Discharging at these points is done by Ross machines.

Consumers, of Toronto—Three charging and three discharging machines.

U. G. I. Co. Pt. Breeze Works, Philadelphia—Three charging and three discharging machines.

Twenty-fifth Ward Works, Philadelphia—Three discharging machines. Ross charging machines in use at this point.

Market Street Works, Newark, N. J.—Three discharging machines.

Mt. Vernon, N. Y.—Two charging and two discharging machines.

Montreal Company—Two charging machines.

Worchester Company, Worcester, Mass.—Two discharging machines.

Detroit Company, Detroit, Mich.—Two 4-tier charging machines, two 4-tier discharging machines.

Arroll-Foulis Machines: Discharging machines in use at two works of Cleveland Gas Co., also at the old Buffalo City Gas Company's Works, Buffalo, N. Y.

No West machines are as yet in use in this country, but are contracted for and being installed at Milwaukee, Lowell, Mass., and New Haven, Conn.

No. 13. What blast pressure should be carried on a water gas machine?

Henry I. **Lea**:—Ordinarily from eighteen to twenty-two inches.

E. J. SHERWOOD:—Eighteen to twenty inches blast pressure should be carried on a water gas machine. If a lower pressure is carried, the generator will produce more CO than will be required to heat up the carburetter and superheater, and consequently fuel will be wasted. With a higher blast pressure, the economy produced in the generator is counter balanced by the power required to run the blower.

CHAS. F. CATTELL:—Fifteen feet to eighteen feet blast pressure. Study your machine and run with pressure that gives best results. All machines do not "heat up" the same with a given blast pressure.

FRED H. BECK:—From 14 to 16 inches of water pressure is usually carried on a water gas machine.

M. N. LATTA:—The blast pressure on the generator should be between 15 and 18 inches, coal being used; 12 inches to 15 inches for coke. A lesser pressure fails to carry over the secondary products of combustion from the generator, the entire consumption being carried on there and creating an undue strain of heat upon the lining of the generator without distributing the combustion of gases throughout the other retorts, which are thereby insufficiently supplied with fuel.

J. T. MASON:—The answer to this question will all depend on conditions and kind of fuel used in the generator.

I should recommend a short and hard blast. With the fuel that is used in Milwaukee, which is our own coke, varying from pea coke to coarse, we use on the eleven-foot set eighteen to twenty inches pressure. On the nine-foot-six set we use twelve to thirteen inches pressure.

J. S. DIXON:—The matter of blast pressure on a water gas machine is probably more directly associated with the amount of gas made than any other single factor. My experience has been that while 10 or 12 inches will give fairly good results, increasing it to 18 or 20 inches will give an immediate increase of 4 to 5 per cent. in the make and without any other change. In order to keep the fuel consumption down as well, and get the very best results, it will be found necessary in increasing the blast pressure to also reduce the time on both runs and blasts. On the other hand, letting the blast pressure reduce down to six or even only eight inches will almost immediately be shown in poor make and lessening candle power and increase of oil and coal per thousand The matter of blast pressure is so important that the gas maker should have a gauge on the blast easily and constantly in sight and in good working order, and be required to record his blast pressure on his running sheet for every blast. To increase the blast pressure in any particular plant, it will be nceessary to either increase the speed of the blower, or if the limit of safe working speed of the blower has been reached, the only alternative is to get a blower of larger capacity. In case a new blower is installed, care should be taken to be sure that the blast pipes are not too small, as a blower will not give good results with too small a system of piping. It does not pay to try to run a blower much beyond its rated speed, as none of the parts, bearings, fan or shell, are designed for such increase, and trouble is sure to follow.

E. M. OSBOURNE:—Opinions differ. From 18 to 20 inches water pressure is good practice, though recent tendency has been toward higher and higher pressure until even 24 inches is often used. By actual test some years ago I found that best results came by manipulating blast pressure; admitting only 6 to 8 inches at first and gradually increasing until about 20 inches was reached. When about five minutes of the eight-minute blast, which we were then using, were up, we blasted about three minutes at full pressure.

E. P. GARTLAND:—Twenty inches blast pressure should be carried on a water gas machine.

ANONYMOUS:—The blast pressure required in a water gas set will depend upon the kind and quality of fuel and its depth, the condition and spacing of checker brick, and upon the design of the set. In general, with the Lowe apparatus of modern design, fuel bed 6 feet deep, checker brick spaced 2 inches, the pressure required beneath the grate will be from 16 to 20 inches. This will allow a drop in pressure from bottom to top of fire of from 5 to 10 inches; coke, either gas house or oven, of good quality, will probably require less difference in pressure between the bottom and top of the fire than anthracite coal.

EDITOR:—In considering what pressure should be carried on a water gas machine, a distinction should be made between total pressure on the machine and differential pressure between the bottom and top of the fuel bed. The amount of CO left in the blast gases depends upon the velocity of aid through this fuel bed. Velocity will not vary greatly if a certain drop in pressure is allowed per foot of fuel depth. Congestion in the superheater or carburetter, or the connections between the various shells, affects only the quantity of the power consumed if a given quantity of air is used, or affects only the volume of air passing through the fuel if the power remains constant. Two water gas machines might be working at the same total blast pressure, one of them having a drop of one inch of pressure per foot of fuel in the generator, while the other would have a drop of only one-half inch of pressure per foot of fuel in the generator. Therefore any rule given for the pressure at which to operate a water gas machine should be in terms of drop in pressure through the fuel bed.

No. 14. What difference in pressure should there be between the top and the bottom of a six-foot fuel bed in a water gas machine?

FRANK LANGWITH:—If the bed is clean, the variations are 6 to 8 inches, according to depth.

E. J. SHERWOOD:--There should be about four inches difference in pressure between the bottom and top of a six-foot fuel bed in a water gas machine when using coke for fuel. Since the quantity of air passed in a given time depends upon the differential pressure, a smaller difference than four inches would not allow a sufficient volume of air to pass through, and too much CO would be formed. If a larger difference in pressure occurred, it would indicate that the blast gases were passing through the carburetter and superheater too easily and too much heat was being carried away which should be used in heating them up.

HENRY I. LEA:—With coke reasonably free from impurities and handled properly a differential of from 5 to 7 inches should be found in a 6-foot fuel bed.

ANONYMOUS:—See answer to No. 13.

E. P. GARTLAND:—There should be a difference of 5 inches pressure between the top and bottom of a six-foot fuel bed in a water gas machine.

No. 15. Can coke be best quenched with a hose or a bucket?

C. A. LUTHER:—Coke can be best quenched with a bucket, as the water is thrown on in larger quantities at one time, and this allows the water to pentrate in the coke and therefore there is less steam rising from the coke this way than by using a hose. A hose will only throw a small stream which has a tendency to cool the outer surface but not the inside, and consequently there is more steam rising, which interfers with the men at work on the retorts.

WALTER M. BLINKS:—It is the writer's experience that stokers prefer to quench coke with a bucket and make a better job of it.

W. S. BALDWIN:—We find that a spray or a bucket is much better than a hose. Where the retorts are pulled by hand, buckets are used. Where 1,300 pounds of coke are pulled in 20 seconds, a spray is used. In the latter case a drawing machine is used.

ALTON LIGHT & TRACTION CO.:—The recent practice at our works has been to quench with the hose, and if care is taken we see no objection to its use.

WM. H. KERIN:—Coke is best quenched with a bucket, as it saves time, and in case water is paid for by the gallon it is much cheaper, as less water is used.

B. F. BULLOCK:—Coke can best be quenched by water thrown from a bucket, because the employe will not waste as much time and is not so liable to wet the coke too much.

FREDERICK EGNER:—I have seen, thousands of times, a man sitting on top of a pile of coke, and squirting water over that which was falling from an overhead trap door, as it was being drawn from the retorts. That is all that that man did until the "draw" was over.

If the man could do nothing else while the draw was going on, that was a good enough way, for as soon as the draw was finished, the coke would be shoveled back on the pile and be gotten out of the way. At the same time the hot steam ascending from the quenched coke, did not add to the comfort of the man on the floor above, and I have more than once seen men knocked over on a hot day, who could have stood very well but for the steam mentioned.

A better way, in my opinion, is to wait until the draw is finished (in a stage floor house), and then a few well directed bucketfuls of water will quickly and effectively quench the coke without inconveniencing anyone; besides, when the quencher has to use the bucket, he is not likely to "drown" the coke to be quenched.

Not to draw this out too long, I hold that in a works without automatic coke-quenching devices, bucket quenching is distinctly a better way, both as to economy in water, labor, comfort of the men and quality of coke.

In a "round floor" retort house, bucket quenching of the coke seems to be the only admissable and common sense method, which seems to be a self-evident conclusion.

H. L. RICE:—Quenching water should be uniform in amount and application.

F. W. STONE:—Our experience has been that we can quench coke better with a bucket than we can with a hose, unless one man sprinkles with the hose while another man draws the coke from the retorts. The coke seems to blacken when exposed to the air before cooling, and the quicker it is quenched the better looking coke we have. The bucket distributes water over the surface of the coke quickly and evenly, and chills it before it has very long exposure to the air. We also seem to use less water when quenching coke with a bucket than with hose.

W. A. ALDRICH:—Where the coke is drawn from the retort to the retort house floor, the bucket is the better; by using a hose, it gets into the men's way, and, owing to the constant steaming, is very liable to be the means of scalding the man who is charging.

A. F. REITEMEYER:—With buckets, as the water can be scattered to better advantage.

JOHN J. POWER:—I have found by experience that coke can best be quenched by using a bucket.

E. C. FLEGER:—With a bucket. Water can be spread better with a bucket than with a hose, so it will take less water and less time.

M. T. WALKER:—Bucket.

NO. 16. How should steam be conducted about a works for minimum condensation and economy, underground or overhead?

E. C. FLEGER:—Overhead, if the pipes are properly covered.

JOHN J. POWER:—With properly insulated steam pipes, it is best to conduct them overhead in and around a gas works.

C. W. WALLACE:—The best way to conduct steam about the works is underground, because there will be less condensation and radiation.

W. S. BALDWIN:—The minimum condensation is obtained by running our steam lines underground, but we find that ease of running and of detecting leaks in the overhead system makes the latter the more economical way of having the lines.

CHAS. F. CATTELL:—Conduct the steam about the works where practicable; when overhead, cover the pipes, and protect covering from moisture.

ALTON LIGHT & TRACTION CO.:—Steam can be conducted about the works by either overhead or underground pipes with equal loss, provided the overhead pipes are properly covered with asbestos or felt covering, and the underground pipes are properly protected similar to heating pipes. In most works it is necessary to run part of the pipes overhead and part underground.

FREDERICK EGNER:—In my opinion this depends somewhat on the general design of the works.

I hold, that wherever it can be done, steam-pipes should be so located that they are out of the way as much as possible, but not so much so as to be inaccessible for repairs or changes.

Consequently, they should be above ground and covered with a good sort of pipe covering; or else, they might be put along with water and gas service pipes used at the works, in suitable conduits with readily removable covering just under the floor.

We might say that in a well designed works, such of the pipes that can be put under ground should be so placed; but this should be in readily accessible conduits, and the balance of the pipes should be overhead, but well covered with insulating material.

ROBERT WATT:—Steam can be conducted about a works with a minimum condensation and economy by covering the overhead pipes with a mineral wool or moulded covering, with an extra thickness of canvas coated with two coats of tar boiled down to the consistency of soft pitch, with a little slate flour, slaked lime or hydraulic cement added to it and applied hot with a brush; the second coat to be applied two or three days following the first. For underground steam pipes the best and most serviceable way is to enclose them in a pipe made of wood, such as are used in various parts of the country for water pipes, or if they are too expensive, enclose the pipes in a wood box filled with sawdust, well packed around the steam pipes.

E. M. OSBOURNE:—Overhead. Pipes should be covered with some good pipe covering. Reference: *Journal of Gas Lighting*, 1886, pp. 280, 329, 373 and 511.

B. C. COBB:—Overhead, but with proper covering, that the piping may be easily gotten at for repairs.

W. A. ALDRICH:—Steam pipes should be in sight wherever possible, but wrapped. The placing of steam pipes underground is a necessity in most works, but in all cases the pipes should be well protected in order to keep the condensation down.

No. 17. Are there any plants in successful operation for manufacturing water gas using oil entirely and no solid fuel? Where are they located?

E. C. **White**:—Oil is used entirely for manufacturing water gas at Stockton, California, and Fresno, California.

Philo Jones:—On the Pacific coast there is a constantly increasing number of plants making "oil gas," wherein oil is the exclusive fuel. The Monterey County Gas and Electric Company operates a Lowe oil gas plant at Monterey, and a Hoyt convertible oil and water gas plant (operated only as an oil gas plant) at Salinas.

Henry I. Lea:—San Jose, Redwood, Los Gatos, Hanford and Watsonville (California) are using straight oil gas apparatus.

W. E. **Brown**:—Yes, at the Forty-fourth Street station of the Consolidated Gas Company, New York.

F. A. **Cressey, Jr.**:—Our plant is a water gas plant, making gas from oil alone, turning out 40,000 per day. We consider it a success.

W. B. **Cline**:—The Los Angeles Lighting Company, Los Angeles, California, is successfully manufacturing about 3,000,000 cubic feet of gas per day, using only oil in generators.

No. 18. How much oil is required to replace the solid fuel in manufacturing water gas using oil entirely?

Philo Jones:—From 12 to 13 gallons of crude oil, from 14 to 21 degrees gravity (Baume), per 1,000 cubic feet of gas for heating and making it consumed in our Hoyt plant. About 32 per cent. of this is used in the heating or blast.

W. B. **Cline**:—About eight gallons of 18° gravity oil for gas making, and about one gallon of 14° gravity oil for heating generators, is required per 1,000 cubic feet of gas made.

No. 19. What changes are necessary to better adapt gas bench furnaces to the use of coal?

Jno. Dell:—Coal for fuel in plain furnaces can be used in any good bench with a little alteration, but it will require much attention and labor to keep up good heats. Almost any arch can be remodeled at a small cost, and a properly constructed furnace for burning a cheap grade of coal built in the same arch. I do not care about referring to styles of construction, as I might drift too much into "shop talk."

J. T. MASON:—With benches of 9's I would recommend that the combustion chamber be enlarged, the nostril or outlets from the furnace into the combustion chamber be made larger, and instead of the chimney's outlets being just above the stack, they should extend above the roof separately or one large stack acting for six benches, three on each side connected by a breeching. This will insure better draft and will also carry the smoke coming from a fresh charge of coal in the furnace, out of the house.

No. 20. What agent can be used for analyzing crude gas which will absorb the ammonia and will not remove any of the other constituents of the gas?

HOWARD E. MANN:—None.

C. H. WILLIAMS:—A comparatively simple method of testing for ammonia in the crude gas is as follows:

Referring to the accompanying sketch, a small accurate dry test meter is connected to the gas supply, and the gas turned on; after passing through the meter, the gas is led through a flask containing a boiling solution of Ca $(OH)_2$.

The $Ca(OH)_2$ will remove any CO_2 which may be contained in the gas forming $CaCO_2+H_2O$; and H_2S which may be present will unite to form $CaS+2H_2O$, and the ammonia will be taken up and absorbed by the water forming NH_4OH, which is broken up by the application of heat and the NH_3 driven off with the boiling.

The ammonia and vapors pass off through the condenser, and a large part is caught in the receptacle at the bottom of the crooked tube.

The NH_3 which is not caught with the condensed steam passes on up through the crooked glass tube, where it comes into intimate contact with the standard acid solution which is dripping down from the measuring glass above, forming $2(NH_4OH)+H_2SO_4=(NH_4)_2SO_4+2H_2O$.

After running a certain quantity of gas through the apparatus and driving off all of the ammonia from the flask, the crooked glass tube is washed down with H_2O, and after noting the quantity of gas passed, and the amount of standard solution used, the receptacle is removed from the containing vessel, and just sufficient of a standard solution of CaOH added to neutralize the solution.

This is determined by adding just sufficient of the base to change a piece of red litmus paper, which has been placed in the solution, to blue.

The containing vessel for the standard acid solution being accurately graduated, a means is given us for determining the amount of $(NH_4)_2SO_4$ in the receptacle, and from this amount the NH_3, which, when compared with the amount of gas used, gives the percentage of NH_3 in the gas under consideration.

Standard solutions and apparatus can be obtained from E. H. Sargent & Co., Nos. 106-108 Wabash avenue, Chicago, Ill., as follows:

Normal acid and basic solutions, 75c per ½ litre.
Litimus test paper 80c per quire, (5c per sheet).
Flasks 12c to 50c each.
Condensers 80c to $1.00 each.
Glass tubing 10c per foot.
Bunsen burners 50c each.

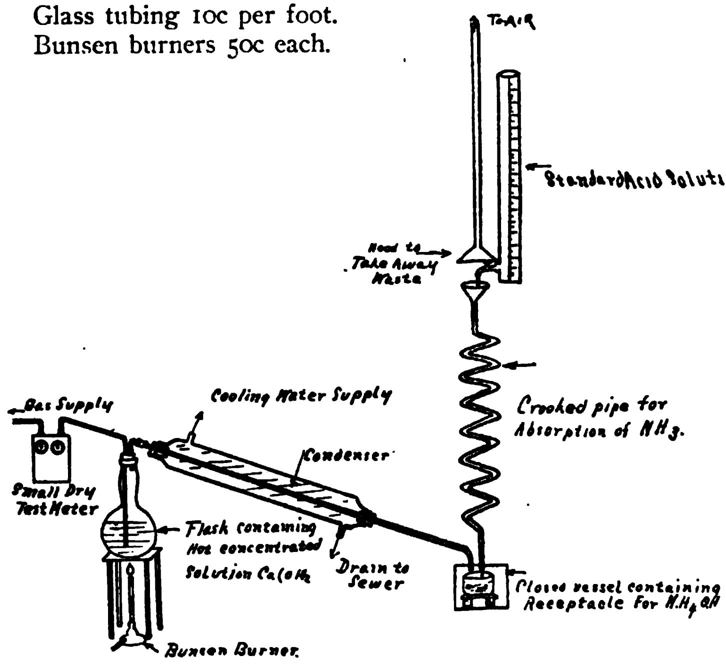


FIG. I.

Walter M. Blinks:—Small bits of pumice stone saturated with syrupy phosphoric acid is usually recommended for the absorption of ammonia in crude gas and should be the first absorption made.

Donald Davidson:—Diluted sulphuric acid.

W. B. CALKINS:—There is no agent that I know of for absorbing the ammonia from crude gas that will not remove any of the other constituents; but if the per cent. of ammonia is what is wanted, what difference does it make if other bodies are removed so long as the total ammonia in the crude gas can be determined?

CLARENCE S. LOMAX:—For this purpose I use a very dilute sulphuric acid that has been previously saturated with gas.

No. 21. How many grains of sulphur in the finished gas can be considered permissible with good practice?

HOWARD E. MANN:—Twelve to fifteen grains per 100 cubic feet.

ROBERT LINDSEY:—From 10 to 15 grains of sulphur other than H_2S per 100 cubic feet.

CLARENCE S. LOMAX:—In order to make gas as free as possible from all objections as to injury to health, vegetable life, fabrics and building materials (which result is necessary in competition with electricity), I consider that five grains of total sulphur per 100 cubic feet is possible and therefore should be considered good practice.

K. M. MITCHELL:—Not over 12 grains per 100 cubic feet of gas.

FREDERICN EGNER:—Newbigging's Handbook states that 22 grains per 100 cubic feet is the maximum allowed, but none of that shall be sulphuretted hydrogen (H_2S).

No. 22. According to text books the finished gas contains about 20 grains of H_2S in ordinary practice. Is it not possible to remove all of the H_2S by use of iron oxide alone, and if not, what is the least amount which can be secured in the finished gas with the use of only iron oxide for purification?

HOWARD E. MANN:—In our practice the H_2S in the finished gas is never more than a trace, and as a usual thing, no reaction for H_2S can be obtained at all.

DONALD DAVIDSON:—It is possible to remove it all with iron oxide.

FREDERICK EGNER:—The questioner states that "According to the text books, the finished gas contains about 20 grains of H_2S in ordinary practice," which is wrong, for it is of sulphur compounds *other than* sulphuretted hydrogen to which this allowance of 20 grains refers.

The oxide of iron will or can remove, under proper manipulation, all the H_2S.

CLARENCE S. LOMAX:—This question is evidently a misprint or a misapprehension. Oxide of iron will remove everything but the faintest trace of H_2S.

No. 23. How can the low temperature of the gas in the stand-pipe be explained in view of the fact that it issues from a retort heated to 2,000° F.?

WALTER M. BLINKS:—The low temperature in the stand-pipe is due to the absorption of large quantities of heat by the volatile products of the coal in assuming a gaseous condition, the heat becoming latent.

C. H. WILLIAMS:—As the gases and vapors pass from the retorts they are still undergoing rapid chemical changes, the supporting of which requires a large amount of heat. The only heat which is available is that within the gas itself, and as the quantity required is large, and the specific heat of the gas relatively small, the change in temperature is rapid and very marked.

V. F. DEWEY:—It does not issue from a retort at 2,000° F.

C. A. LUTHER:—As gas is a poor conductor of heat and say it leaves the retort at 2,000 degrees Fahr., its temperature will naturally drop instantly as soon as it comes in contact with the stand-pipe, as the stand-pipe is exposed to the outer air. Therefore the heat that is absorbed by the stand-pipe naturally radiates; consequently it is kept always at a low temperature.

CLARENCE S. LOMAX:—The low temperature of the gas in a retort stand-pipe is accounted for by the fact that while the retort itself actually has a temperature of 2,000° F., the coal itself does not attain that temperature until near the end of the charge, and a large part of the heat of the retort is taken up in the chemical changes of distillation and expansion of the solid materials into gases.

W. E. BROWN:—Charging a retort causes a sudden lowering of the temperature, the gas passing up the stand-pipe before it has time to get heated. If the charge is left in long after the gas has been thrown off the temperature will rise in the stand-pipe and stopped pipes will be the result.

J. WALLACE SHAEFFER:—The low temperature of the gas in the stand-pipe is due to the latent heat of vaporization and to the contact of the gas with the comparatively cool portions and particles of tar.

W. M. SITES:—The low temperature of the gas in the stand-pipe, about 150° F., as compared with the high temperature of the gas in the retort, about 2,000° F., is due principally to the rapid absorption of heat by the volatile constituents of the coal in assuming the gaseous form. This heat is latent in the gas in much the same manner as it is latent in steam. See Mentor on "Self-Instruction in Gas Manufacture." A portion of this heat is also lost by radiation.

E. C. FLEGER:—The stand-pipes are surrounded by cold air which acts in the same capacity as a cooler or condenser.

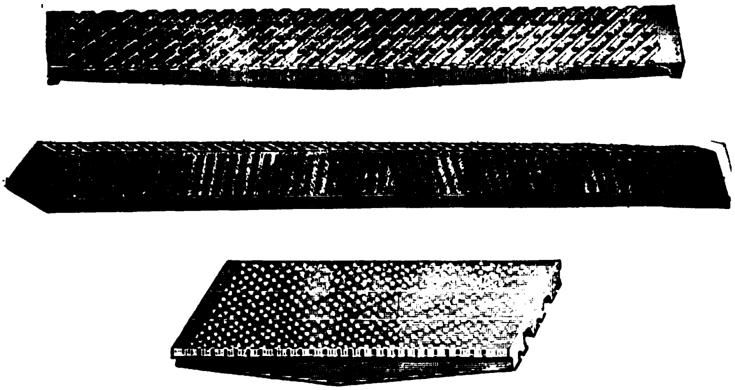
JAMES FERRIER:—The loss of heat (or preferably temperature) is due principally to the amount of heat rendered latent in the transmutation of so much matter from the solid to the gaseous state. Euchene (Paris, 1900) found that the temperature of the volatile products (gas, tar, etc.) in the mouth of the retort, just above the coke, was 1,222° F. Part of this (the writer thinks) must be regarded as heat radiated from the coke and the walls of the retort, as Euchene found that in the stand-pipe between 7 and 8 inches above the mouth-piece the temperature had fallen to 800°. Heat is lost in the mouth-piece and stand-pipes (1) by radiation, (2) by expansion in an ascending column, and (3) by the breaking up of some of the heavier hydrocarbons which probably does not cease after leaving the retort.

DONALD DAVIDSON:—This must be due to the large amount of latent heat absorbed by the coal in volatizing. The coal does not become nearly as hot as the retort until almost all the gas has been given off. This is much the same case as a kettle of water on the fire. The fire is very much hotter than the escaping steam.

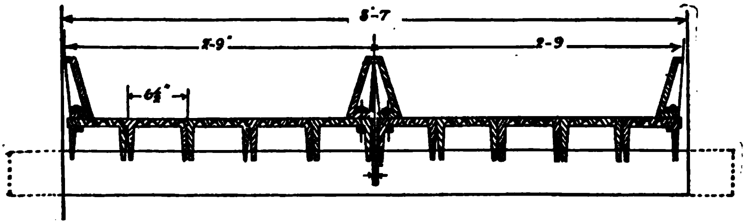
EDITOR:—Several of the above answers are correct, but by example might be made more plain to the non-technical reader. The low temperature of the gas in the stand-pipe has puzzled many inexperienced men. The largest factor in fixing this low temperature can probably be best explained by comparing it with the application of heat to water. No matter how much or what the intensity of heat is applied to water, its temperature will simply cause a larger amount of water to assume the form of steam, thus absorbing the excess of heat supplied. The conditions in a retort are probably not greatly different from this. Much of the bituminous matter of coal would have a natural condition of a vapor or a gas at a temperature very much lower than the temperature of the retort, and when taking the gaseous or vapor form, its thermal capacity would increase enormously and the excess of heat would be thus absorbed, leaving the temperature of the mass much lower than its surroundings, and without sufficient time contact with the sides of the retort to take even approximately their higher temperature.

No. 24. Has anybody tried to burn breeze on the grate bars designed for burning sawdust?

J. Chas. Andrews:—The following illustrations show several styles of grate bars designed for burning sawdust, also a grate designed by the Stears-Rogers Mfg Co., of Denver. The side and center grates of the latter style form a tuyere, which will distribute the air equally around the bed. This grate was originally designed to burn slack and is said to give good satisfaction. The rate of combustion is controlled by the amount of air delivered, and is easily regulated by a valve. The cheapest class of fuel can be used, such as dust, culm, screenings, etc. It will be noted that this grate bar is very similar in design to some of those used for burning sawdust.



GRATE BARS FOR BURNING SAWDUST.



GRATE BARS FOR BURNING SLACK.

FIG. II.

No. 25. Assume coal contains 1.5 per cent. sulphur and .75 per cent. is left in the coke; the unwashed gas will contain less than the missing amount. Where does the balance of the sulphur go to, and is any of it absorbed by the tar, and if so, how much?

Howard E. Mann:—In the various condensations from the plant we find H_2S compounds, CS_2 compounds, and CNS compounds, which represent a large proportion of sulphur in the original coal. In the purifying boxes there is a large aggregation of sulphur from various compounds of unknown composition, and we have also found sulphites, hyposulphites ($H_2S_2O_3$), scientifically known as thiosulphates, and thionic acids. In the oil obtained from the compression of gas in the Pintsch gas works compounds of CNS and COS have been found. We have never taken the trouble to work out the percentages in these compounds.

W. B. Calkins:—Sulphur exists in coal tar in many different combinations, such as carbon bisulphide (CS_2), carbon oxysulphide (COS), thiophen (C_4H_4S) and its derivations, etc. The total amount of sulphur in coal tar will vary with the temperature of carbonization and the per cent. of oxygen in the coal, and although even Prof. Lunge gives no analysis of total sulphur in tar, all sulphur that cannot be accounted for in the gas, crude liquor, coke, etc., can safely be estimated as being removed in the tar, for no sulphur or sulphur compounds ever get away.

H. B. Harrop:—From a series of determinations made by me in one American works the following results were obtained, representing the distribution of the sulphur of the coal among the products of carbonization. This is fairly typical, but it should be remembered that all the conditions vary from time to time and place to place. The item "tar" included a certain amount of ammonia water held in suspension.

(1)

Coal, 2,000 lbs.. at 1.09% S		21.80 lbs.
Coke, 1,400 lbs., at .78% S. (weight based on yield per month), lbs.	10.92	
Crude gas from stand-pipes (equiv. to 9,640 ft. finished gas) at 785 gr. per 100 ft.)	10.81	
Unaccounted for	.07	
	21.80	

(2)

Crude gas from 2,000 lbs. coal (at 785 gr. S. per 100 ft. finished gas)		10.81
Tar, 131 lbs. at .76% S. (weight based on yield for month; S. based on tar in wells at time of gas test)	1.00	
Am. liquor, 427 lbs. at .20% S. (figures on same basis as tar)	.85	
S. left in boxes, based on shipments for year	8.00—	
Purified gas, 9,640 ft. at 32 gr. S. per 100 ft.	.44	
Unaccounted for	.52+	
	10.81	

No. 26. How much water is required per thousand cubic feet in the manufacture of coal gas for all purposes including boiler feed water, scrubber, washer, etc.?

F. C. Webber:—All of the water which we use at our gas works is metered, and we pay for the amount of water used as shown by the meter. This amount includes all of the water used for all purposes, such as boiler feed, scrubber, seals, holder tank, coke, etc. Taking the gas made for the last two years and the amount of water used, as shown by meter, we use an average of 97.5 gallons of water per thousand cubic feet of gas made.

W. A. Aldrich:—It depends entirely on the economy practiced round a works. We utilize rain water, conduct it to the boiler room and use it there. In December we made 5,689,000 cubic feet of coal gas, and used a little over 600,000 gallons of water.

F. W. Stone:—The average of two gas works, one of which makes twenty million feet, and the other twenty-four million feet per year, was from 30 to 40 gallons of water used per one thousand cubic feet of gas made. The amount used depended on the amount of air condensing surface available, the amount of water used for the scrubber, and the size of the holder pits it was necessary to keep warm in the winter time.

No. 27. Are wet lime purifiers in use at all in modern practice?

W. E. Brown:—Lime is not used in solution, the disposal of the foul liquid being difficult.

No. 28. Are there any gas companies using ammonia for sulphur purification beyond the amount of sulphur incidentally picked up in the scrubbers, and if so, what is the process and how much of the sulphur is removed?

PAUL DOTY:—References: Claus's Process, Newbiggings Hand Book, page 113.

No. 29. How much CS_2 can be removed from the gas without the use of lime, and what is the best method for securing this result?

K. M. MITCHELL:—The following article is taken from the *London Journal of Gas Lighting* of August 11th, 1903:

"Freeing Gases from Carbon Dioxide.—Tohl A., of Hoenningen-on-the-Rhine, Germany. No. 13,466; June 16th, 1903.

"In the ordinary scrubbing processes employed in gas works, illuminating or heating gas is, the patentee points out, freed from sulphuretted hydrogen; but the gas obtained is not free from sulphur. The sulphur constitnent of the purified gas is caused by the presence of carbon disulphide, which 'cannot be removed by known purifying processes.' But a means has been discovered, he says, for freeing gases of all kinds from carbon disulphide vapor, consisting in submitting the gas—either before or after it undergoes the ordinary purifying process to which it is submitted in gas works for removing the various impurities—to a further washing with a washing medium which completely absorbs the carbon disulphide; any convenient form of scrubber being employed for this purpose. The substance 'which produces this result of completely absorbing the carbon disulphide from gas, without detrimentally affecting either its illuminating or heating properties,' is the oily constituent of the products resulting from the distillation of vinasse. The oil is obtained, together with the acqueous solution when vinasse (that is to say, the residual liquid which remains when sugar is removed from beet sugar molasses by fermentation or by any desac-charifying process—for instance, by means of barium oxide, strontium oxide, or calcium oxide), is submitted to distillation.' The vinasse is heated for obtaining the oil, so that dry distillation is effected. The distillation may take place, for example, over an open fire in retorts; and the distillation products are condensed and collected. An oil and an equeous liquid are obtained, which are separated by pouring off the oil floating on the water. The oil, when dried, presents the property of absorbing large quantities of disulphide; and by heating, either with or without simultaneous introduction of steam, the oil, previously used, may be again rendered suitable for absorbing carbon disulphide from gas."

The above appears in the Register of Patents.

CLARENCE S. LOMAX:—This subject has had my attention for the past ten years. I have tried every method mentioned in the patent literature of the United States, Great Britain and Germany. Some of the processes do the work but partially, and all of them are too expensive to be considered from a practical standpoint when compared with the lime method. I have, however, succeeded in developing a process which avoids the objections above mentioned, and I expect shortly to be able to bring this matter before the gas fraternity.

No. 30. What is the best and quickest method for determining how long to keep a foul box of oxide of iron in service?

HOWARD E. MANN:—By the way it revivifies.

B. E. CHOLLAR:—Oxide at best is uncertain material. It is variable, capricious, unsteady and inconstant. The proportion of free sulphur mingled with the mass is not a true criterion of its usefulness, and in fact I don't know what is. The best way I know of is—when it won't work any more, and you can't revive it, throw it away.

C. A. LUTHER:—By using an apparatus made by Eimer and Amend, No. 205 Third avenue, New York City, called Tutwiller Apparatus No. 9381.

With the above apparatus a test can be made in a very few minutes of the amount of sulphur entering and leaving the first box, which will show the amount of sulphur removed and whether or not it is economical to continue the foul box in use.

JAMES W. DUNBAR:—When there are sufficient numbers of purifiers and the condensation and purification capacity is ample, the oxide box need not be changed as long as it will permit gas to pass through it. By the admission of 2 per cent. of air, I have let a box of oxide remain in use three years, and only changed then because of oxide becoming hard; therefore as long as the first oxide does not show excessive back pressure, it should not be changed, unless the second box becomes foul and the admission of air fails to prevent the removal of H_2S in second box.

E. M. Osbourne:—I take it this refers to plants using two or three purifying boxes. We get a line on time by actual test, keeping a record. Sometimes back pressure will spoil one's calculations, forcing one to take off box sooner than record would indicate.

O. O. Thwing:—"The accompanying cut illustrates an easy method of determining whether the bed of oxide is doing service or not.

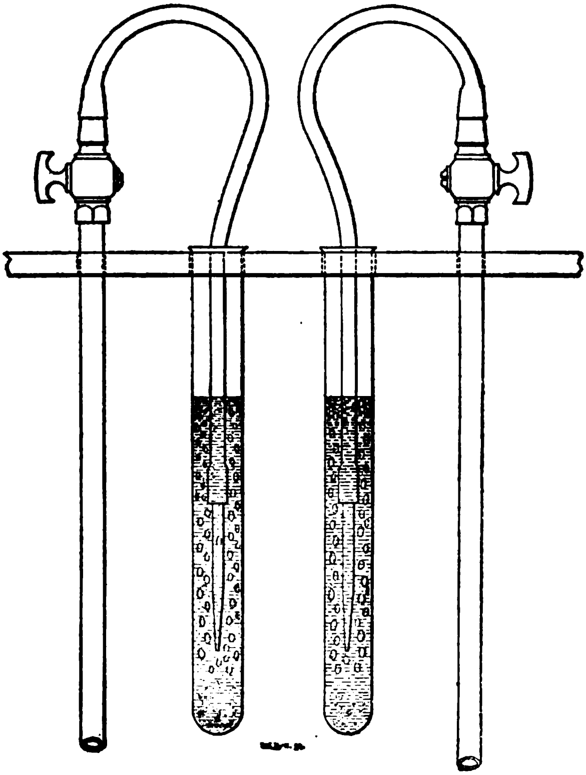


FIG. III.

"Byron E. Chollar describes the arrangement as follows:

"It frequently happens that both the inlet and outlet of a purifying bed will show an equally foul test with lead paper, while the bed may yet be doing work. The above shows how this condition may be ascertained; a pipe and stop-cock leading from each side of the bed, rubber tubes with glass nozzles of equal size attached, and a weak solution of permanganate of potash are all that are required. Put equal quantities of equal strength of the solution in the test tubes, insert the glass tubes and turn on the gas in both at the same time.

"Foul gas will make the solution clear almost immediately. If the bed is doing work, the inlet side will clear up quicker than the outlet side.

"Two or three grains, or perhaps less, of permanganate to the quart of clean water is sufficient. Keep the solution in a well-stoppered bottle, and don't make up too much at a time."

The above is taken from the "All American Gas Wrinkles," published by the Western Gas Association, May, 1903, page 98.

My opinion is, judging from the few experiments that we have been able to make, that when the outlet of a box clears up in about four or five times the length of time it requires the inlet to clear up by this method, it is time to change the box, as it would be taking out less than 30 per cent. of the sulphur in the gas.

No. 31. What labor-saving machinery can be advantageously used in a works manufacturing about two hundred thousand cubic feet of coal gas per day?

Frederick Egner:—For a works making about 200,000 cubic feet of coal gas, the inclined system of retorts, with a wheelbarrow charging arrangement, together with a good, satisfactory half-depth regenerative furnace for the benches, and a *"superintendent who knows how,"* would be at all times the best labor-saving device. But supposing the inclines cannot be installed for any reason (as for instance, that the retort benches there already are good, or the expense to change would be too high), then I recommend a charging and drawing device which is a German invention, and actually seems better than several more pretentious stoking machines, and which is highly recommended to me by men in whom I have confidence. The cost of this machine is quite moderate; it can be placed into any existing retort house, and is worthy of being booked up by those who wish to improve.

W. A. Aldrich:—Where there is no stoking machinery, a scoop eight feet six inches long, eleven inches wide and seven inches deep, with a tee handle made of three-quarter-inch rod iron firmly braced to the end of the scoop, for charging, saves labor, time and gas; two are required for each bench. On the scoop being filled (it holds about 175 pounds) with coal, one man takes hold of the handle, raises it, and another places a semi-circular bar under it; a third man takes the other handle; it is then raised into the mouth of the retort; the end man pushes it in, turns it over and pulls it out again, the men catching the scoop on the "horse." This is repeated a second time with the other scop, reversing the order of turning.

A hopper for firing hot coke is also a great labor saver; a large hopper with a nose piece fitting the fire-box door and suspended overhead with a wire cable, which runs along and over the top of the benches. The coke is drawn from the retort and is caught in the hopper, and pushed into the furnace. When not in use, the hopper may be drawn away from the bench.

No. 32. Is any CS_2 removed with the ammoniacal liquor in the scrubber or the ammonium sulphur compounds which are formed, and if so, what is the nature of the chemical combination?

Howard E. Mann:—Believe that the action of NH_3 on the CS_2 is to form ammonia sulphocyanide and ammonium sulphide by first forming the sulphocyanic acid according to the empirical formula $CS_2+NH_3=HCNS+H_2S$. The addition of the excess of NH_3 to this reaction will give the ammonia salts of each of these acids.

J. A. Schaeffer:—In all probability ammonium sulphocyanate ($CNSNH_4$) is formed by carbon bisulphide and free ammonia.

$CS_2+4NH_3=CNSNH_4+(NH_4)_2S$.

Donald Davidson:—It is probable that some CS_2 is taken out in the form of ammonium thiocarbonate $(NH_4)_2CS_3$. $(NH_4)_2S+CS_2=(NH_4)_2CS_3$.

H. B. Harrop:—$CS_2+4NH_3=NH_4CNS+(NH_4)_2S$; this happens. It is also asserted that CS_2 combines with normal ammonium sulphide to form thiocarbonate: $CS_2+(NH_4)_2S=(NH_4)_2CS_3$. Besides these, there are several doubtful reactions to be found in the books.

No. 33. What is the specific heat of the products of combustion of coal gas?

W. B. Tuttle:—The specific heat of the products of combustion of a coal gas may be ascertained as follows. It is assumed that by volumetric analysis, the gas in question is found to be composed of

Carbon Dioxide (CO_2)	1.8 per cent.
Olefiant Gas (C_2H_4)	5.9 per cent.
Oxygen (O_2)	1.1 per cent.
Carbon Monoxide (CO)	3.6 per cent.
Methane (CH_4)	42.8 per cent.
Hydrogen (H_2)	40.9 per cent.
Nitrogen (N_2)	3.9 per cent.

The weight of one cubic foot of CO_2 at 60° and 30″ is 816.65 grains, and therefore in one cubic foot of the above gas 14.70 grains of CO_2 will be present. CO_2 cannot be burned, and therefore 14.70 grains of CO_2 will be present from this source after combustion.

The weight of one cubic foot of C_2H_4 is 528.25 grains, and therefore 31.17 grains will be present. C_2H_4 is composed of 6 parts of carbon to 1 part of hydrogen by weight, and therefore 26.72 grains of carbon and 4.45 grains of hydrogen will be present. Since 8 parts by weight of oxygen are necessary, to completely consume 3 parts of carbon, the combustion of the 26.72 grains of carbon will produce 97.97 grains of CO_2. Since 8 parts of oxygen to 1 part of hydrogen are necessary for combustion, 4.45 grains of hydrogen will produce 40.05 grains of H_2O (water).

The oxygen will unite with either the carbon or the hydrogen during combustion and may therefore be neglected for the present.

The weight of one cubic foot of CO is 522.03 grains and therefore 18.79 grains will be present. Since 4 parts by weight of oxygen to 7 parts by weight of CO are necessary for combustion, the 18.79 grains of CO will produce 29.53 grains CO_2.

The weight of one cubic foot of CH_4 is 300.84 grains and therefore 128.76 grains will be present. CH_4 is composed of 3 parts of carbon to 1 part of hydrogen by weight and therefore 96.57 grains of carbon and 32.19 grains of hydrogen will be present.

Since 8 parts of oxygen are necessary to completely consume 3 parts of carbon, the combustion of the 96.57 grains of carbon will produce 354.09 grains of CO_2.

Since 8 parts of oxygen to 1 part of hydrogen are necessary for combustion, the 32.19 grains of hydrogen will produce 289.71 grains of H_2O.

The weight of one cubic foot of hydrogen is 36.98 grains and therefore 15.12 grains will be present. Since 8 parts of oxygen to 1 part of hydrogen are necessary for combustion, the 15.12 grains of hydrogen will produce 136.08 grains of H_2O.

The weight of one cubic foot of nitrogen is 520.82 grains and therefore 20.31 grains will be present. N_2 cannot be burned and therefore 20.31 grains of N_2 will be present after combustion.

In the combustion of the various gases 573.57 grains of oxygen will be used and since only 6.92 grains were present in the coal gas, the rest, 747.05 grains, must be supplied from the air.

Since air is composed of 23 parts of oxygen and 77 parts of nitrogen, there will be 2,500.96 grains of nitrogen left after combustion.

From the above calculations it will be seen that the combustion of one cubic foot of coal gas, with the necessary air will yield 496.29 grains CO_2, 465.84 grains H_2O and 2,521.27 grains of N_2.

The specific heat of CO_2 at constant pressure is 0.217.

The specific heat of N_2 is 0.2438.

The specific heat of superheated steam is 0.4805.

$$\begin{array}{rcrcr}
496.29 & \times & 0.217 & = & 107.695 \\
2521.27 & \times & 0.2438 & = & 614.686 \\
465.84 & \times & 0.4805 & = & 223.836 \\
\hline
3483.40 & & & & 946.217
\end{array}$$

$$946.217 \div 3483.40 = .2717.$$

The specific heat at constant pressure of the products of combustion of coal gas is about .2717, assuming that the temperature is above the boiling point of water and below that at which a marked increase in the specific heat of CO_2 and N_2 occurs.

H. B. Harrop:—For the figures of least doubtful value on the specific heats of CO_2 and H_2O at high temperatures, refer to lecture before the American Gas Light Association by Prof. A. H. White, published in the *American Gas Light Journal* of Nov. 16th, 1903, and elsewhere.

ROBERT LINDSEY:—Specific heat of nitrogen at constant pressure is 0.244. Speific heat of CO_2 and water vapor varies with the temperature. The following table compiled by M. E. Derval shows the mean specific heat at different temperatures:

°C.	°F.	H_2O Vapor.	CO_2.
0	32	0.420	0.184
100	212	0.438	0.192
200	392	0.456	0.200
400	752	0.492	0.215
600	1112	0.529	0.228
800	1472	0.565	0.240
1000	1832	0.602	0.251
1200	2192	0.638	0.261
1400	2552	0.674	0.270
1600	2912	0.711	0.278
1800	3272	0.747	0.286
2000	3632	0.784	0.293
2200	3990	0.820	0.300
2400	4352	0.856	0.306
2600	4712	0.893	0.312
2800	5072	0.929	0.318

To find the average specific heat of the mixed products of combustion, multiply the weight of each of the products by its corresponding factor of specific heat and divide the sum of the products by the total weight.

No. 34. What is the cheapest means for obtaining CO_2 for gas making purposes?

E. J. SHERWOOD:—The CO_2 can be obtained cheapest from the chimney flue, but it will be mixed with nitrogen, however. It costs but very little to obtain it from this source, while other methods involve the use of costly chemical agents.

No. 35. Is there not some way to completely gasify tar?

JAMES FERRIER:—Tar is composed partly of solid carbon held in suspension. This has never been gasified, except perhaps in the electric arc.

JAMES W. DUNBAR:—Tar cannot be converted into a permanent gas by any direct method of distillation. William E. Barnes, Civil Engineer, of London, England, publishes a manual on the manufacture of gas from tar, oil and other liquidated hydrocarbons, in which he claims that gas of 16 c. p. can be produced from tar for 4c per 1,000 cu. ft. The process seems complicated and has not attained commercial success.

H. B. HARROP:—This question appears to suggest that tar would be more valuable as gas than as tar. See Schilling's "Gasbeleuchtung," 3rd edition, page 230, *et seq.;* and Lunge, chapter on "Applications of Coal Tar Without Distillation," showing that all attempts heretofore made to gasify tar have proved impracticable.

W. E. BROWN:—Yes, but the game is not worth the candle. Stopped pipes and pitch in the hydraulic main and trouble all around is the result.

G. FALKENSTEIN:—I gasify my tar entirely by running the tar into the mouthpiece of retort No. 1, the vapor of the tar going through this retort, at the end of the same to a 5-inch pipe connecting the No. 1 with the upper retort No. 2, the gas going through No. 2 to standpipe and hydraulic main. The retorts are charged with coal in just the same way whether tar is running or not. In the retort No. 1 there is also a one-inch pipe put through the mouthpiece lid and oil put on top of the coal, the vapor of the oil being fixed in the same way as that from the tar; I think the best way would be to have a small still, to be either heated by the waste heat of the bench or in larger works direct-fired, to make the tar into pitch and only the vapors of the tar to be run through the retorts. I cannot give the candles per gallon, but in this process steam is not necessary and no retorts are laid off for oil gas. If the retorts are only used for coal and oil, it is not absolutely necessary to have two retorts combined, but the oil pipe will have to extend close to the back end of the retort. The make of the retorts can be doubled at will at short notice.

No. 36. Has anybody done anything to determine the question in last year's box regarding the depreciation of coal?

ALTON LIGHT & TRACTION CO.:—Our experience in the question of storage would indicate that there is a loss of about 20 per cent. in coal which is stored one year.

IRVIN BUTTERWORTH:—Yes. Mr. Garnet McKee, of the Detroit City Gas Company, has recently made an investigation of this subject, and has submitted his finding to the McMillin Companies' Association. He finds that the deterioration is much more rapid at first than later, and that it is virtually limited to the gases occluded in the coal.

No. 37. What is the best and quickest means of determining when an iron oxide has ceased to do useful work?

HOWARD E. MANN:—By the lead acetate test.

J. M. COLES:—By the practical experience of well-known gas engineers, a box of iron oxide containing 50 per cent. of sulphur compound is considered unfit for use. The amount of sulphur can be determined by taking a small sample of iron oxide from a batch you have decided to test and by passing liquid carbon bisulphide through this. The sulphur will be carried over to a vessel provided for its return, and there deposited. After this has been dried the amount of sulphur is weighed, and you have the per cent. of sulphur the iron oxide contains.

ROBERT LINDSEY:—A convenient and inexpensive method of finding out how the boxes are working consists of an ordinary test tube of, say 12 inches long and 1 inch diameter, fitted with a two-hole rubber stopper, through which are placed glass tubes, one reaching to within four inches from the bottom of the tube, the other just below the stopper. A solution of lead acetate of convenient strength is placed in the tube three inches in depth. A strip of white bibulous paper ten inches long, preferably such paper as photographers use for drying prints (as it is free from sulphur), is immersed in the solution in the tube. It will be kept moist by capillary attraction. The long tube is of course the inlet, and it should be bent so that the gas will impinge against the paper an inch or so above the surface of the liquid. As the test is continuous, an inspection from time to time will show at once the condition of the boxes.

R. B. BROWN:—The limit of the working of iron oxide bed has heretofore been placed by the number and capacity of boxes in series, and not by the fact that at any time the said bed became inoperative or had "ceased to do useful work." It has been definitely determined that the foul box in a four-box series is doing a great deal of useful work at the time that it has to be shut off on account of the point at which the gas becomes clean approaching dangerously near to the outlet of the last box. The United Gas Improvement Company at Philadelphia is now using a six-box series and, I am told, finds the same conditions obtain there, though of course in a less degree. Therefore it may be said that under existing practice an iron oxide bed does not "cease to do useful work."

E. M. OSBOURNE:—We throw it away when it ceases to do our work, and fails to revivify. We settle this by actual test.

J. A. SCHAEFFER:—The best and quickest means of determining when an iron oxide bed has ceased to do useful work is to make a quantitative estimation of H_2 S in the gas before and after passing through the box. A quick method is to use the United Gas Improvement Company's H_2S apparatus, which expresses the grains of H_2S per 100 cubic feet of gas.

E. W. SMITH:—If the boxes properly purify when freshly filled, place white paper coated with sugar of lead in the escaping gas direct from purifiers, and if purifiers have ceased to do their work, the paper will turn black.

No. 38. What is the advantage or disadvantage of using steam for decarbonizing retorts?

CLARENCE S. LOMAX:—By the proper use of a steam jet, the carbon may be properly removed from a retort in from five to fifteen minutes, and the retort kept in service without the loss of a single charge. The advantage over the old method of burning the carbon out slowly and losing a charge or more is readily seen. If properly handled, there is no more damage done in the retort than by the slower method.

E. C. FLEGER:—The disadvantage of using steam is that it will open up the pores of a retort more than air.

J. H. ENRIGHT:—There is no advantage in using steam for the removal of carbon from retorts; on the contrary, I know of but few better ways to destroy them.

W. E. BROWN:—Steam and air will take carbon off quickly and without damage to retorts.

J. T. MASON:—The answer to this quetion in my experience has been on the disadvantageous side. Steam alone will not do the work. You must add air by making your steam jet act as a syphon. Then the steam has to be thoroughly dry and to do this you will have to add a superheating coil to jet, either by running a return coil in the combustion chamber of the bench or in the same retort that is being decarbonized. The cost of keeping this coil in repair will offset any advantage that might be gained by the method.

I have used steam to decarbonize retorts and with the best conditions possible have found it will work only on a very hot new retort. If the retort is at all below a bright orange, the steam will turn it black before taking out the carbon. Likewise if the retort is cracked and the carbon fills the crack, the steam method will not work in a short enough period of time to make it pay.

R. SHACKETTE:—The only advantage of steam over air in decarbonizing is in the saving of the carbon.

EDITOR:—The answers to this question bring out some of the disadvantages of both air and steam. We are successfully using a decarbonizer at Denver in which both air and steam are used, and while it is not yet in perfect shape, the results secured from it are satisfactory and we think much more desirable than from the use of either air or steam alone. A pipe of greater diameter incloses a pipe of lesser diameter, the outer pipe carrying compressed air and the inner pipe carrying steam. Holes are drilled in the outer pipe for the escape of the air and steam in a manner calculated to cut channels through the formation of carbon, and smaller holes are also drilled in the inner pipe midway between the holes in the outer pipe, through which steam escapes into the space between the external periphery of the inner pipe and the internal periphery of the outer pipe. As this steam must travel forward or backward to find an opening in the outer pipe through which to escape, it keeps the temperature of the outer pipe down to a safe point, preventing rapid deterioration, and the mixture of escaping steam and air is intended to be so proportioned that the heat generated by the burning of the oxygen of the air and the freed oxygen of the steam is just sufficient to counterbalance the heat absorbed by decomposing the steam. This decarbonizer will be more fully described either in the Wrinkle Department or at some later time. It has reduced the time of decarbonizing 80 per cent.

No. 39. What are the advantages or disadvantages of using compressed air for decarbonizing?

CLARENCE S. LOMAX:—The disadvantage of using compressed air consists in the fact that too high a temperature may be generated in this way in the retort wall itself.

C. W. WALLACE:—In using compressed air for decarbonizing retorts, you can do the work in less time (4 hours) than by the use of steam, and the life of the retorts will be longer.

W. E. HARTMAN:—Best method we have tried. Cheaper than the steam process and much quicker. We have a 2-inch wrought iron pipe from the water gas blast pipe running along the front of the benches with tees at convenient points for connecting up a piece of 2-inch pipe which is laid in the retort to be decarbonized.

R. B. Brown:—The advantage of using compressed air for decarbonizing is the increase in the rapidity with which this operation can be accomplished, together with avoidance of any cooling of the very high temperature produced in the interior of the retort, increasing the wear and tear on mouth piece, standpipes and scurfing fittings.

J. T. Mason:—The advantages of this method are as many if not more than the disadvantages of the preceding method. With air under twenty-five pounds pressure per square inch or more, any retort, no matter how bad the carbon is, can be cleaned out thoroughly and only one charge missed. It will take a little longer where the retort it broken or cracked, but it will do the work and do it quickly. All that is needed is the compressor, a tank and a line of pipe in front of the benches with valves and union connection at each bench to connect hose, or what is better, a swing joint that will reach any retort in the bench. The pipe which extends about two-thirds the length of any retort need not be larger than one or one and a half inches.

R. Shacklette:—The advantage of air in decarbonizing is in the rapidity with which it can be accomplished.

No. 40. Does ammonia have a greater affinity for H_2S than for CO_2?

Howard E. Mann:—Greater for H_2S.

John Gimper:—Affinity for CO_2 is greater.

E. J. Sherwood:—Ammonia has a greater affinity for H_2S than for CO_2. Strong acids have greater affinity for strong bases than for weak bases and vice versa. Both H_2S and CO_2 are acid in character and CO_2 is the weaker, H_2S being strong enough to displace carbonates.

Donald Davidson:—Greater affinity for CO_2.

J. A. Schaefer:—The charts below, which are tabulated from results obtained while experimenting with samples of ammonia liquor taken from the washer-scrubber, tower scrubbers, condensers, etc., will clearly show that ammonia has a greater affinity for CO_2 than for H_2S. For instance, at 70° F. the amount of CO_2 present is from six to twenty-three times as much as H_2S.

Clarence S. Lomax:—Ammonia has a greater affinity for carbonic acid.

7,000 Grains Liquid taken from Standard Scrubber, Temperature Room 70° Fahr.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Temperature.	Ammonia Present in Grains.	Ammonia Grains Driven off.	Ammonia Percentage Driven off.	Total Grains of Ammonia Driven off.	Total Percentage of Ammonia Driven off.	H_2 S. Present in Grains.	H_2S Grains Driven off.	H_2S Percentage Driven off.	H_2S Total Number of Grains Driven off.	Total Percentage of H_2S Driven off.	Grains Driven off per Grain of NH_3.	Total Grains Driven off per Grain of NH_3.	CO_2 Present in Grains.	CO_2 Grains Driven off.	CO_2 Percentage Driven off.	CO_2 Total Number of Grains Driven off.	Total Percentage of CO_2 Driven off.	Grains Driven off per Grain of NH_3.	Total Grains Driven off per Total Grain of NH_3.
70	217.7					11.9							217.8	1.0					
80	217.0	.7	.8215	.7	.3215	11.0	.9	7.564	.9	7 564	1.286	1.286	216.1	1.0	.4608	1.0	.4608	1.4285	1.4285
90	215.6	1.4	.6452	2.1	.9648	10.1	.9	8.182	1.8	15.13	.64.29	.8571	212.1	8.9	1.806	4.9	2.258	2.786	2.833
100	206.5	9.1	4.221	11.2	5.145	8.8	1.8	12.87	3.1	26.05	.1429	.2768	197.2	14.9	7.026	19.8	9.125	1.6374	.1878
110	203.0	8.5	1.695	14.7	6.753	8.3	.5	5.682	3.6	26.56	.1419	.2449	194.1	3.1	1.527	22.9	10.55	.8857	.1558
120	197.4	5.6	2.759	20.8	9.825	7.5	.8	9.638	4.4	36.98	.1429	.2167	190.5	3.6	1.855	26.5	12.21	.6429	1.805
130	194.6	2.8	1.419	23.1	10 61	6.6	.9	12.00	5.3	44 55	.3211	.2294	152.1	38.4	20.16	64.9	29.91	13.712	2.809
140	181.8	13.8	6.835	36.4	16.72	6.1	.5	7.575	5.8	48.75	.03759	.1593	130.1	22.0	14.77	86.9	40.08	1.654	2.3872
150	174.3	7.0	3.861	43.4	19.94	4.4	1.7	27.87	7.5	63.04	.2429	.1728	126.1	4.0	3.074	90.9	41.89	.5714	2.0946
160	119.7	54.6	31.82	98.0	45.01	3.5	.9	20.45	8.4	73 60	01648	.08572	119.9	6.2	4.917	97.1	44.74	.1135	.9908
170	111.9	2.8	2.339	100.8	46.30	2.6	.9	25.71	9.3	78.16	.3214	.09223	96.4	23.5	19.64	120.6	55.30	8 365	1.1963
180	87.5	29.4	25.15	139.2	59.81	.8	1 8	69.22	11.1	93 28	.06123	.08533	48.7	47.7	49.48	168.8	77.55	1.5202	1.2925
Boiling 190	68.8	18.7	21.38	148.9	68.40	.5	.3	37.50	11.4	95.81	.001604	.07654	20.9	27.8	57.09	196.1	90.36	1.4865	1.817
5 Min. Boiling	51.1	17.7	25.78	166.6	76.26	.4	.1	20.00	11.5	96.99	.005649	.06902	5.7	15.2	72.71	211.3	97.38	.8588	1.2682
10 Min. Boiling	31.5	19.6	38.36	186.2	85.54	.2	.2	50 00	11.7	98 34	.01162	.06283	3.5	2.2	38.60	218.5	98.30	.11277	1.1475
25 Min. Boiling	23.8	7.7	24.44	193.9	89.06	.0	.2	100.00	11.0	100.00	.01648	.06138	6.0	3.5	100.00	217.0	100.00	.4546	1.119
Add K. O. H.	00.0	23.8	100 00	217.7	100.00	.0	.0		11.0	100.00		.05466	0.0	0.0		217.0			.9968

No. 41. Which will be freed from ammonia liquor the more quickly by heating, H_2S or CO_2?

Howard E. Mann:—CO_2 will be liberated more quickly than H_2S.

John Gimper:—H_2S will be liberated first.

E. J. Sherwood:—The CO_2 will be freed by heat from ammonia liquor more quickly than will H_2S. The affinity of NH_3 for H_2S being stronger than that for CO_2, the sulphide formed in the first case will be more stable than the carbonate with the latter, and when heated the CO_2 will be driven off first.

For the action of these compounds, see Remsen's "Inorganic Chemistry."

J. A. Schaefer:—This question can easily be answered by referring to the charts accompanying answer to question No. 40. Upon heating ammonia liquor and testing at each rise of 10° F., the percentage of freed H_2S is much greater than that of CO_2. This can be seen by comparing columns 10 and 17.

Donald Davidson:—H_2S.

No. 42. What general laws can be laid down to secure fuel economy in a gas works?

E. C. Fleger:—By firing a given quantity at a given time. Same as charging.

Chas. F. Cattell:—Economy. Teach the foreman or gas maker to check up each month all materials received and used, taking careful inventory at end of each month, in order to show up discrepancies.

E. W. Smith:—There are different ways to economize in fuel in water gas works. If blast is continued too long, the bed is consumed to no advantage. Also the use of too much steam under the fuel bed tends to deaden it. The only thing remaining to be done is to clinker, whereby we lose a great deal of good coke if not separated and turned back to fire-pot.

John Gimper:—Properly constructed benches and good management of same.

Z. M. Jenks:—This answer will apply only to a water gas works, which is the kind now under my care.

Do not crowd your boilers; have ample grate and steam capacity so as to consume your fuel slowly. Locate your boilers as close to your generating apparatus as practicable. Use only up-to-date apparatus, taking care to have ample depth and area in generator, and then use brains as well as muscle in operating same.

R. B. BROWN:—Prominent among other sources of fuel loss in a gas works are the use of direct acting steam pumps and small isolated steam engines, which between condensation, leakage and general inefficiency of design will absorb from four to five times the power required by using a central power plant and electrical distribution.

W. E. BROWN:—Use breeze for boiler fires. Fire up frequently in furnaces; every two hours is better than every three. If furnace is allowed to get low clinkers will be the result, while if kept full up the consumption of coke will be much reduced.

FRANK N. DAVIS:—See answer to question No. 67.

B. C. COBB:—Proper attention to drafts and dampers. Strict attention to practical rules by men when firing. Steam pipes properly covered. Use of high grade fuel. Above all, a foreman or superintendent who understands his business, with the ability to enforce rules and instill into the minds of his men economical ideas.

No. 43. Have any new labor-saving machines been brought out during the past year?

FRED H. BECK:—Yes, a very good ditching machine, which has been used successfully among other places at Sioux Falls, S. D.

G. A. BRONDER:—The only labor-saving machines brought out last year that I have any personal knowledge of are those I manufacture, and are as follows:

Four-tier drawing machine, working 4 rakes simultaneously and operated by one man.

Four-tier charging machine, working 4 scoops simultaneously and *operated by one man.* Scoops are fitted with horns to spread coal well to sides of retorts.

Three-tier charging machines, same as above otherwise.

Three or 4-tier combined charging and drawing machine operated by one man only.

Improved coke quenching conveyor, connected with exhauster, carrying away all steam and smoke, thereby keeping ironwork in cellar dry and permitting same to be left exposed and to be built of steel protected by paint, and obviating any necessity of having brick or cement arches which are so liable to crack from floor vibration of machine-worked retort houses.

Conveyors for handling coal and coke from coal cars to coke shed, pile or bins entirely by machinery, including the storing of coal in coal shed or taking coal from cars or shed to retort house bins, charging, drawing and quenching coke and carrying it to coke store.

Improved turntables for machines supporting practically all the load on the central pin, thereby requiring the minimum power (or labor) to turn them when loaded.

No. 44. Would it pay to put dampers on the stack of each bench, with convenient means for closing to prevent cooling by air currents, whenever furnace is opened for clinkering or recharging?

E. J. Curley:—That a damper, and a separate one at that, for each stack is requisite has been demonstrated in our works during the last 35 years. In order to work benches profitably, it is of first importance to maintain a high, uniform heat. It is, I believe, the general practice in works to clinker every morning and night, and in doing so it is necessary for the stoker to rid his furnace of the fire in order that he may cut off the clinkers from the sides and rear end, during the operation of which there is a vast amount of cold air passing through the bench and which quickly begins to tell on the retorts by their cooling and contraction. The stoker is the first who is made cognizant of its first effect in the chilling of the clinker he is cutting, which renders it more difficult to cut and prolongs the operation. During all this time and until the coke is again ignited from the sides of the furnace (the latter having lost considerable of its heat in the meantime), the temperature of the retorts has decreased from that of white heat to one approaching a dark color. To this cause is mainly due the rapid destruction of retorts, as no material will long stand the sudden and rapid changes of temperature which a bench of retorts worked at a high heat are subject to under their present arrangement. A stack damper will save the retorts this great variation in temperature and will also materially increase the ease and rapidity with which the furnace may be clinkered on account of the clinkers not getting chilled.

O. O. Thwing:—With straight fire furnaces, using coke for fuel, dampers on the stack of each bench are desirable, and will pay by retaining the heat of the bench during clinkering and firing. With coal firing, however, my experience is that the use of dampers tends to clog up the flues leading from the furnaces, and I would not recommend it under such circumstances.

Chas. F. Cattell:—It pays to put a damper on each bench. *Be sure* to have handy means to work them, so the men will not have to *climb* to operate said dampers.

Henry I. Lea:—I believe the use of dampers for this purpose has proved very successful at Station B in St. Louis. Mr. O. O. Thwing doubtless has some data in this connection.

Walter Thomas:—Yes, for open fires, but would be dangerous for regenerators.

W. E. Brown:—Yes, but dampers must be automatic, and a good automatic damper is badly wanted. The rush of primary air during clinkering and filling up the furnace has a very destructive effect on the bench.

No. 45. Is it not possible that air would be more effective if introduced at a point nearer the purifiers, than if introduced immediately behind the exhauster? Nitrogen is inert and objectionable, while oxygen is an active chemical element, and a portion of the oxygen of the air may be absorbed by the scrubber water and tarry matter, or may unite chemically with other portions of the gas, and never reach the purifiers as free oxygen.

John Gimper:—Yes.

Henry I. Lea:—The only proper place to admit air for revivification "in situ" is at the inlet of the purifiers. If the proportion is correct, there need be no trace of it (except the nitrogen) at the outlet of the purifiers and no chance need to be taken on cooling too suddenly such portions of the gas as will be met by the air at the introduction.

H. L. Rice:—Some engineers claim that they do not lose in candle power if the revivifying air is introduced close to the hydraulic. The claim has been made that with a specially designed appliance much more than the usual per cent. of air can be introduced close to the hydraulic without injury. As there appears to be much difference of opinion as to the absolute effect of the introduction of revivifying air on the candle power, and as the information available is much confused by the different methods of application, and by the facts sometimes relating to only coal gas or again to only water gas or to mixtures, and as the oxygen present in the gas from various causes is another conflicting element in results cited, the writer feels that the subject is one worthy of special research such as has been devoted at times to various questions in our Association.

J. A. Schaefer:—It seems as though it would be a good plan to introduce air at a point near the purifiers, as 100 volumes of water at 60° F. and 30 inches pressure will absorb 2.99 volumes of oxygen, which is undoubtedly absorbed by the water in the standard scrubber when the air is introduced behind the exhauster.

Clarence S. Lomax:—Owing to the fact that gas comes to the exhauster saturated with different gases, including oxygen, and also the fact that the temperature of the gas is steadily decreased after passing the exhausters, I believe it makes no difference at which point the air is introduced. We introduce ours before the exhauster.

No. 46. We have manufactured gas with the A. O. Granger's water gas system since 1882 and we are very much pleased with the plant, but the oil is thrown cold directly over the generator. Is there any other way to distribute this oil in ebullition over the generator or at the bottom of the heater with advantage?

E. D. Clary:—We use the Granger-Collins Water Gas Apparatus in our works, and for the past 6 or 8 years we have vaporized our oil by means of an oil heater in the gas take-off pipe and have introduced it into the bottom of the superheater about a foot below the superheater arch.

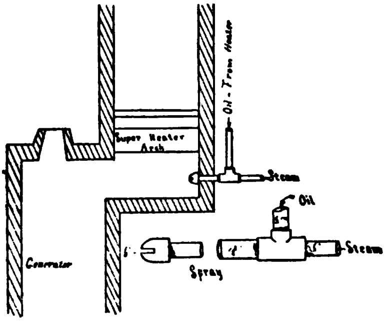


FIG. IV.

The oil is forced into the set with a pump, but a jet of steam is introduced into the oil just before it enters the set to thoroughly spray it and insure its meeting the gases, as they come from the generator, in a fine mist. With this arrangement we get an average result of about 5½ candles per gallon of crude oil; gas corrected for temperature in determining gallons per foot.

Our spray consists simply of a piece of pipe with a cap on the end of it with a slit in the cap ⅛-inch wide. When spray is put into set, the slit is set horizontally. Below is a sketch of the arrangement.

E. M. Osbourne:—Force it through heater, then spray it over fuel. Think a small Love setting would save enough in a short time to pay for itself.

Anonymous:—An oil heater heated by steam of high pressure would probably be advantageous in this case.

No. 47. How long should the checker brick be used in the carburetter or superheater of a water gas set without changing?

C. W. Wallace:—There is no fixed time at which the bricks in the carburetter and superheater should be changed. It depends a great deal on the oil at command; some oils deposit more carbon than others. The principal way that a water gas maker determines when the bricks are dirty and need cleaning is by the decrease in the make of gas per minute. The carburetter and superheater should be put in good shape in the late fall, so as to be in good condition for the heavy make in December and January.

Leonard Fitzgerald:—Checker brick in the carburetter and supreheater should not be replaced until the increase in oil and fuel per M. shows that they are covered with carbon and burned out. This condition will generally result after the machine has been run about 2,000 hours.

B. F. Bullock:—No set time can be given for using brick work in carburetter or superheater, as it depends very largely on the way the machine is run and the quality of oil used. On a small set of Improved Lowe I can call to mind, when averaging 80,000 cubic feet per diem, we had to change the checker brick in about two months. Our rule was to change when the results obtained fell so low that it was economy to put in new bricks.

E. M. Osbourne:—That depends on many conditions—work done, heats carried, oil used, coke or other fuel used. All have a bearing on the time when checkers cease to be economical. Large machines running heavily or continually in Chicago plants are changed every three or four months. They now use a cheaper brick than formerly, and seldom replace them, throwing them out after one using. Some plants use best brick for top of superheater.

H. H. Powell:—The checker brick in carburetter and superheater, being absorbers of heat, will perform that duty best if placed with spaces of one inch between; have found them to work well as long as the brick should be left unchanged.

Anonymous:—The frequency with which the checker brick of water gas apparatus should be cleaned will depend upon the kind of fuel and oil and the conditions of running. With a good fuel which does not produce a great quantity of dust and small cinder, and with a good gas oil and proper heats, superheater bricks should run from three to four months continuously day and night without cleaning, and carburetter bricks should run from one and a half to two months. The condition of brick should be carefully watched through sight holes, however, and the back pressure in carburetter and superheater during blasting should be noted; if these denote a considerable deposition of dirt on the checker brick, the brick should be cleaned.

No. 48. How would you prevent carbon from forming in the take-off pipe of a water gas set?

Henry I. Lea:—Carbon is not formed in the take-off pipe of a water gas set. Its deposits there cannot be entirely prevented, but may be largely reduced by continued, careful watching of the seal overflow pot, of the temperatures throughout the apparatus and of the color of the gas at the top of the superheater. The depth of the seal will ordinarily care for itself after water supply has been adjusted. This adjustment, by the way, is varied so that from seven to eleven gallons of water per thousand feet of gas made, are run into the seal. A large portion of this water is of course picked up mechanically by the hot gases passing through the seal, the balance being that which appears at the overflow pot, the surface of which must be watched as an indicator of the condition of the gas as it reaches the seal.

If lamp-black is being formed in the set, the seal pot will of course show lamp-black. On the other hand, if the oils are not being properly fixed, oils will show on the surface of the seal pot. The careful gas maker will stay between these two points and will aim at obtaining a clear tar, showing, with reflected light, traces of yellowish gold. The exact consistency of the tar at this point and the shade of color obtained will be determined by the particular grade of oil being used, even when assuming that the best conditions obtain in each case.

Similarly, the color of the crude gas leaving the superheater will be affected by the quality of the oil and the details of operation; ordinarily the best results are obtained when the opening of the superheater sight-cock shows crude gas of a golden straw tinge. The exact shade suited to any one oil may be determined with a little practice, as the variation in color, owing to the different proportions of hydrocarbons going through, may be readily noticed through any one run. If instead of having the rich straw color, the gas at this point appears more as blue smoke, it will be found unsatisfactory for illuminating purposes, as the blue indicates a drop in the proportions of the hydrocarbons present. On the other hand, gas may readily be made too heavy and this would be indicated by a density in the cloud of gas issuing, and by the presence of noticeable particles of lamp-black, if the excess be carried far enough.

It is impracticable to give any set rules for the operation of a water-gas plant, but it is safe to say that with any of the crude and gas oils ordinarily used, a gas of rich straw color at the outlet of superheater, coupled with clear tar having no indication of either lamp-black or oils on the surface of the seal overflow pot, is an indication that a fixed gas of ordinarily satisfactory illuminating value is being made.

W. E. HARTMAN:—This carbon is formed as a result of the gas being exposed to so high a temperature that the hydrocarbon constituents are decomposed into their elements, hydrogen and carbon, the carbon being deposited in the take-off where it becomes caked upon the inside of the pipe. This carbon is formed at the expense of the hydrocarbons or illuminants in the gas. To prevent it, study the heats. There should be a gradual decrease in temperature in the machine from the top of the superheater, which should be coolest. To secure this graduation of temperatures, we used successfully two steam connections, one at the bottom and one two-thirds of the way up on the superheater. By turning on one or both of these during some of the blows, we can keep down the temperature to the desired point. On another machine we replaced the superheater checker brick, leaving 4 inches space between bricks. By thus decreasing the heating surface, we found that we can carry the desired heat without the aid of steam.

J. D. SHATTUCK:—By keeping the temperature down in top of superheater.

J. Wallace Schaefer:—At our Milwaukee plant we have found what we consider to be an effectual means for preventing the deposition of carbon in the take-off pipes of our Lowe sets. We have tapped all of our wash-boxes on the side and as low as possible and have inserted 2-inch pipe as shown in the accompanying sketch.

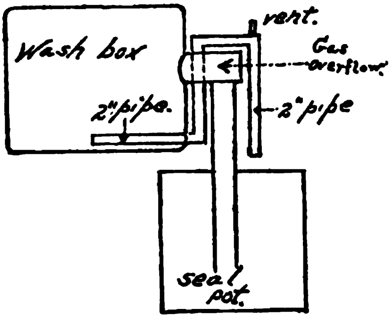


FIG. V.

It will be seen from the sketch that when the run is on, the increased pressure in the box will cause the water and tar to be discharged through the 2-inch pipe into the seal pot, thus keeping the bottom of the wash-box clear of tar and pitch. A vent at the top of the bend prevents any syphoning action.

E. M. Osbourne:—Think this is caused mostly by too high heats. We often run steady eight weeks or longer, yet have no take-off pipe trouble. Yet I have seen it plug solid in one day, making it necessary to take down the whole take-off pipe.

Anonymous:—The deposition of carbon in the take-off pipe of a water gas set should be prevented by maintaining sufficiently low and regular heats in the checker brick, so that no lamp-black is made in the machine.

No. 49. What effect does high heat have on the production of ammonia per ton of coal carbonized?

Robert Lindsey:—The effect of high heat lessens the production of NH_3. A make of from 9,500 to 10,000 cubic feet per ton results in the greatest yield of NH_3. The loss of NH_3 at high heat is expressed by the equation, $NH_3+C=HCN+2H$, NH_3 being decomposed into hydrocyanic acid and free hydrogen.

WALTER M. BLINKS:—High heats appear to increase the formation of cyanides at expense of ammonia production. Maximum product of ammonia is reported by a good English authority to occur at medium heats such as will produce with good coal 10,000 cubic feet of gas to ton.

E. E. EYSENBACH:—It lessens the amount produced, probably due to dissociation.

W. E. HARTMAN:—Below 500° C. is the best temperature for maximum yield of ammonia. At high carbonizing temperatures, ammonia is very unstable, being decomposed into its constituent elements, nitrogen and hydrogen, this decomposition increasing with the temperature.

FRED H. BECK:—Anything above a moderate heat has a tendency to lessen the amount of ammonia made per ton of coal.

R. B. BROWN:—With most coals high heats reduce the production of ammonia per ton of coal carbonized.

No. 50. Is wash water taken from and returned to relief holder tank successfully used in water gas practice?

HENRY I. LEA:—Yes. Sometimes by pumping relief holder water through the condensers and then back to relief, using independent water supply for scrubbers. At other times the principle employed in "domestic" hot water circulation is taken advantage of and a separate boiler is used for maintaining circulation. This arrangement renders it impossible to form steam in the boiler and avoids practically all danger.

CHAS. F. CATTELL:—Yes, at Ardmore, Pa., Lower Merion Gas Co. No drain from works.

FRED H. BECK:—Yes.

E. M. OSBOURNE:—Yes.

ANONYMOUS:—Water from the wash box can be successfully run through a relief holder tank and used repeatedly. As this water contains sulphuretted hydrogen, etc., it cannot be run into a storage holder tank without fouling the purified gas.

No. 51. Assuming that some coal must be stored to insure a supply at the works, is it better to leave the same coal stored all the time for any emergency that might arise, and use fresh coal as far as possible, or is it better to use the oldest coal, and should the old coal be cleaned out once a year?

W. E. Brown:—The answer to this question depends greatly on locality. Some coals lose but little by storage, while others rapidly deteriorate. Slack coal in British Columbia loses 40 per cent. of its gas in twelve months.

J. H. Nelson:—On account of slacking and constant deterioration of the gas-making qualities of coal, it is advisable to use the old coal first.

Walter M. Blinks:—This depends on quality of coal; should it break up much on storage it should be cleaned up as often as possible, as fine coal oxidizes more rapidly. With coals that do not slack, the chief depreciation occurs the first year, and assuming a proper building is provided for storage it will be better to carbonize fresh coal and not touch the reserve supply. No consideration of the desirability of using up and checking coal stock is taken in this.

New York & Richmond Gas Company:—As the rate of depreciation of coal decreases by time, the actual percentage of value lost is less if the stored coal is unused until emergency occurs, when its use is necessary.

E. C. Fleger:—Oldest coal should be used first, and should be cleaned out once a year if the coal shed is so arranged that it can be gotten at without any extra expense.

Walter Thomas:—If coal is small, it is best to clean up coal storage once a year. Find it more profitable to use fresh mined coal.

Alton Light & Traction Co.:—It is our opinion that the old coal should be cleaned out once each year.

Irvin Butterworth:—According to a thorough investigation of this question recently made by Mr. Garnet McKee, of the Detroit City Gas Company, we should charge the freshest coal first, especially the fine stuff, and let the oldest coal remain in storage indefinitely or until needed.

B. C. Cobb:—Use fresh coal, for in most plants it can be more economically handled, and it is questionable if coal in protected storage deteriorates enough to make it wasteful.

No. 52. Has any progress been made in this country towards the commercial recovery of sulphur and cyanides?

The United Coke & Gas Company:—There are a number of factors which contribute in making the success of the recovery of cyanides in the United States rather questionable. These may be summed up under two captions:

(1) There is a great accumulation of stock of cyanides on hand in Europe, which accumulation has been caused by shutdown of the Transvaal gold mines during the Boer war. As is well known, the cyanides of potash and soda are used extensively in the extraction of gold from the ores.

(2) A number of processes are now being exploited for the manufacture of cyanides synthetically from its elements or by the conversion of ammonia. This latter process is now being used in a factory at Perth Amboy. The United States patents on this process are the following: 708079, 708833, 711910 and 716-350.

In this process a mixture of metallic sodium and carbon is heated to a temperature of about 600 to 750 degrees F., and ammonia is introduced. The following reaction then takes place: Sodium and ammonia form sodium amide:

$Na+NH_3=NaNH_2+H$.

This sodium amide is then furthermore converted into sodium cyan-amide, according to the following reaction:

$NaNH_2+C=Na_2N_2C+4H$.

This sodium cyan-amide is then at a temperature of about 1470 degrees F. converted into cyanide of sodium, according to the following reaction:

$NaN_2C+C=2NaCN$.

The sodium used in this process is manufactured electrically at the Niagara Falls.

Another process has been vividly discussed at the recent congress of applied chemistry at Berlin in 1903. This process, which has been invented by Frank & Caro, will be exploited on a large scale in the factory in course of erection in Switzerland.

Frank & Caro had specially in view the production of cyanides as being the more valuable combination of nitrogen. For this purpose, they used at first barium carbide, because it fixed the nitrogen directly according to the equation:

$BaC_2+N_2=Ba(CN)_2$.

The barium cyanide obtained could be worked up into potassium ferrocyanide and alkaline cyanides. Further investigations showed that, to better advantage, calcium carbide could be used, the manufacture of which is more economical than of barium carbide.

The product of the reaction of nitrogen upon calcium carbide in red hot iron muffles is calcium cyan-amide:

(1) $CaC_2+N2=CaCN_2+C$.

By extraction with water and by remelting with carbon and carbonate of alkali, cyanide is obtained according to the following equations:

(2) $2CaCN_2+4H_2O=2Ca(OH)_2+(CNNH_2)_2CNNH_2)_2$.

(3) $(CNNH_2)_2+Na_2CO_3+2C=$
$2NaCN+NH_3+H+3CO+N$.

There are a great many other processes of similar nature which it would take too long to describe. Anyone who desires to post himself in regard to the present state of industry can do so by perusing a recent publication, "L'Industrie Des Cyanures," by R. Robine and M. Lenglen, Paris, 1903.

The question is now whether these processes will be able to manufacture cyanides as cheaply as they can be obtained by working up the spent oxide of gas works or by the direct extraction of cyanides from gas, is is done extensively in Germany under the Bueb patents.

This question cannot be decided at the present moment, as our knowledge as to the manufacturing expenses is too limited, and strict secrecy is being preserved in regard to these manufacturing expenses. It would therefore appear unwise at the present moment for any one to spend large amounts of money in the equipment of gas works for the recovery of cyanides.

E. E. EYSENBACH:—The recovery of cyanides has very little commercial promise. The best reason for removing it is to save meters and service pipes.

No. 53. What is the best means of enriching coal gas with oil and what results can be obtained in candles per gallon?

FREDERICK EGNER:—In my experience I have found nothing so efficient to accomplish the object of the above inquiry as that of making oil gas in *one* of the retorts of a coal gas bench, the rest of the retorts of which are regularly charged to make coal gas.

Averages of work carefully kept for several years demonstrates that by the method I employed, the result in candles per gallon of oil were remarkable, viz., about 2,644 candles.

In other words, using Youghiogheny coals alone, I obtained an average of 10,976 cubic feet of 16 candle gas per ton of 2,240 lbs.

But, when using the same kind of coal, in the same retorts, and substantially with the same men, but in addition gasified on an average of 4.8 gallons of 63° gas naphtha per ton of coal carbonized, I obtained an average of 12,163 cubic feet of 19.66 candle gas per ton of coal (with the oil mentioned). This will figure out, as commonly expressed, the number of "candles" mentioned above.

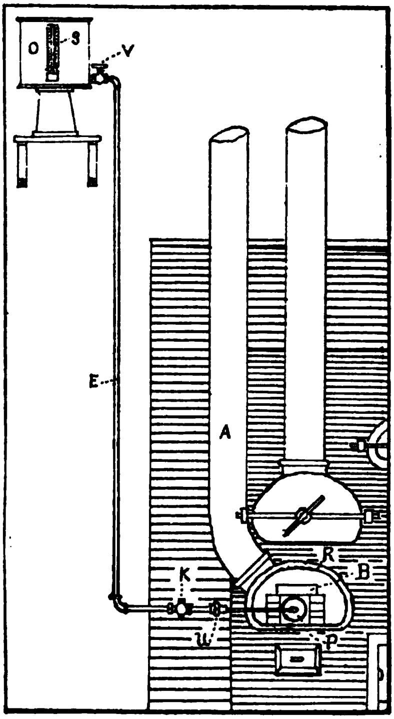


FIG. VI.

Or, it brings the results to equal 45.30 lbs. of sperm, as others might figure it. As the weight of oil used was only 30 lbs. per ton of coal and the additional gas alone approximates 45.46 lbs., not taking into the calculation the additional 3.66 candles by which the total of the coal gas was enriched, my statement must appear paradoxical; and yet it is absolutely correct, as I have every reason to believe. It is more over an important fact, I think; and while I have not answered the question, it may interest members of the Ohio Gas Light Association to know how, in detail, I obtained such results. With the permission of the Editor of the Question Box I will herewith describe the method, which I do not designate "my method" because although I have successfully used it for a number of years, I first learned it when assistant engineer of the then Metropolitan Gas Light Company of New York City, under the direction of my friend, Mr. I. Herzog, then that company's chief engineer.

The annexed drawing will serve to better illustrate the subject.

Fig. 6 represents a portion of the front elevation of a bench of 5's (not drawn to scale), in which R is the left hand lower retort section, back of the lugs which usually support the lid and cutter bar. The black circle P represents a piece of 3-inch cast iron pipe, laid loosely into the retort and extending from the front end to within a foot of the back or "seat" of the retort.

B represents a number of fire brick laid around the said pipe so as to cover it, and in part protect it from the otherwise too intense heat of the retort. U is a union and reducing bushing or coupling (in which only leather washers should be used), to allow of readily connecting or disconnecting the oil supply pipe E, which leads to the small oil-measuring tank O, set at any convenient point some distance from the retort bench. K is an iron stop cock; A, the ascension pipe leading from the retort to the bridge and dip pipe, and so on to the hydraulic main. V is a valve on the oil tank and G, a small gauge by means of which the contents of the oil tank can be seen and read off, without removing the tank cover, which should be on said tank for safety's sake, as well as to keep out dust and other dirt.

Fig. 7 shows a very essential feature of the whole arrangement, and without which the results previously mentioned may not be obtained. This figure represents a hydraulic main in section, showing also a portion of the ascension, the bridge and dip pipe, and a by-pass to the seal of the said dip pipe. This by-pass is best made of 2-inch wrought iron pipe with the crosses, plugs, flange or other union and a cast iron cock.

After the preliminary work has been done, it is always the work of only a few minutes to change from making coal to oil gas, or vice versa. The preliminary work consists of, first, drilling a hole on the side of the retort mouthpiece, back of the lid lugs and about 4 inches from the bottom. This hole must be large enough to freely pass a piece of ½-inch gas pipe; and it can then be closed with a lump of luting clay until wanted. The ½-inch pipe is provided with an ell and a nipple about 6 inches long, to project about that distance into the cast iron pipe in the retort; and after this is done and the union screwed up tight, the opening around the ½-inch pipe in the 3-inch pipe is also closed with luting clay, so that whatever oil is run into the retort must run toward the rear end of it; for the same reason it is well to raise the outer end of the cast iron pipe, by laying a split brick under it. The lid of the oil retort ought to have a ¾-inch hole, fitted with a plug, in it, so that one may look into the retort occasionally, if desired, to observe the heat and gas made. After all is ready, the cast iron pipe laid into the retort and covered, the oil connection made, etc., the oil is turned on, and if crude oil is used, made to feed into the retort at the rate of about 8 gallons per hour (naphtha 10 to 12 gallons per hour), and the by-pass opened. Of course this by-pass must be closed whenever the lid is removed from the front of the retort to clean possible stopped pipes, or for any purpose, so as to prevent drawing air into the hydraulic main. The rate of flow of oil can easily be established by watching the gauge on outside of oil tank and timing the flow of oil per ten or fifteen minutes. After this is established the stop cock K should be marked with a file or any sharp instrument, so that thereafter when shut off, it can be quickly turned on again without further timing it.

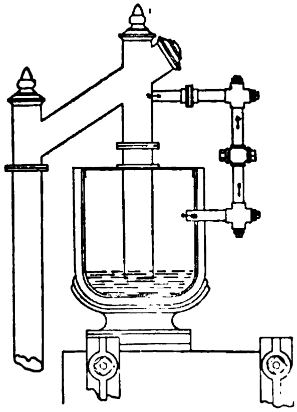


FIG. VII.

If the coal gas is to be enriched only from 3 to 4 candles, one oil retort will serve 10 to 12 coal retorts, but, when even only one bench is in operation, this method can often be employed to advantage, especially if an increase in supply of gas is imperative and a second bench cannot be gotten ready quickly enough, or else would be too much. I chose a bottom retort because bottom retorts generally are not as hot as middle or top retorts, and too much heat is not desirable for the oil retort, although one can easily keep down the heat in same by running enough oil into it. For a like reason, the attendant of a coal bench in which there is one oil retort, must fire up for all he is worth, to keep the heat up in the bench, for the oil retort will take more than its proportion of heat. The heat in the coal retorts must be the fireman's gauge for keeping up the heat in the bench. If the coal retorts are hot enough, the heat in the oil retort is easily regulated by the flow of oil. The coal retorts may be "white-hot," as a retort house fireman might term it; but the oil retort should be kept at a dark red. Taking out the plug in the oil retort lid, the gas issuing therefrom should be of a brownish color; if black, the retort is too hot or not enough oil running in; but these details must be learned by practice and experience, and if my general directions are followed, the results are sure to be obtained.

The proper running of the exhauster is another point absolutely necessary to the successful operations described. In the *American Gas Light Journal* of March 23d, 1896, on page 455 (Vol. 64), will be found illustrated a cheap and accurately reliable exhauster engine governor of my invention (not patented), which will do the work well for anyone who may care to use it. The exhauster should be run, so no matter what the seal may be, as to have not over about one-tenth pressure in the retorts, which means sometimes a very slight vacuum in the hydraulic main, or mostly just an even balance. But though the pressure may be a tenth or two more, still the results described are sure to be obtained, if my directions are followed.

JOHN J. POWER:—I am using a hot scrubber located close to hydraulic main. Where the warm liquor from the main is again brought into intimate contact with the warm gas previous to the gas entering the scrubber, I introduce gas naphtha in a small stream or "dropping," and we find that the use of ½ gallon of oil to 10,000 cubic feet will increase the illuminating power of the gas 2 c. p.

G. FALKENSTEIN:—See answer to No. 35.

No. 54. What method can be used for enriching gas with tar?

IRVIN BUTTERWORTH:—At the meeting of the Ohio Gas Light Association in March, 1887, Mr. E. W. Hamlin, of Wilmington, Ohio, described a successful method employed by him for enriching gas with tar, and his paper thereon was printed in the *American Gas Light Journal* of May 2nd of that year.

G. FALKENSTEIN:—See answer to No. 35.

JAMES FERRIER:—The "Peebles Process" accomplishes this. In some places tar has been run into thick paper bags and charged into retorts.

No. 55. How can waste heat from coal benches be most advantageously used?

CLARENCE S. LOMAX:—This question of heat economy can, I believe, be best solved by the use of the full-depth regenerative bench in any work of sufficient capacity to warrant the introduction of the same.

JAMES W. DUNBAR:—First, by recuperation. Second, by utilizing waste heat from free firing bench to heat water in boilers generating steam to be used around the gas works.

H. L. RICE:—By erecting one stack for the benches and drawing the flue gases through an economizer.

No. 56. Are there any gas engines in satisfactory use in gas works for driving exhausters, and how are they regulated for a fluctuating gas make?

WALTER THOMAS:—Yes, there are many used for the purpose in Great Britain. The engine maintains a steady speed sufficient to take care of maximum make. The fluctuation is easily taken care of by the use of an equillibrium valve operated by a governor connected between inlet and outlet pipe of exhauster. R. & J. Dempster, Gas Engineers, Newton Heath, Manchester, England, build exhauster machinery operated by a gas engine.

No. 57. What is the best means for ventilating a retort house?

HENRY I. LEA:—Ordinarily a properly designed Louvre does the work very successfully.

R. B. BROWN:—The chief cause of trouble in the ventilation of a retort house is the mingling of steam with the smoke. In considering any ventilation scheme, first arrange to remove your steam from the point at which the coke is quenched, mechanically. The smoke can then be taken care of by a number of different methods efficiently.

Irvin Butterworth:—At Detroit, in our retort house containing benches of 8's and charging and drawing machinery, the coke is drawn onto an inclosed and inclined platform in the basement immediately under the charging floor, and running the full length of the stack, where it is quenched by means of a hose, and whence it is drawn when quenched through openings in the side of the inclosed platform into buggies running on tracks laid on the basement floor under the lower edge of the platform. During the time of drawing and quenching a large power-driven exhaust fan, connected by a large pipe with the inclosed platform, withdraws all the smoke and steam from the same, allowing practically none to escape either into the basement or into the retort house above.

No. 58. What is the cheapest method of removing from gas, sulphur compounds other than H_2S?

W. B. Calkins:—No method now in common practice among large gas companies will completely remove CS_2 and organic sulphur compounds from the gas. Some patented pieces of washing and scrubbing apparatus, using caustic ammona liquor in connection with sulphide of lime and iron oxide purifying boxes, claim to reduce all sulphur compounds to a very small per cent.

What the cheapest method would be, will depend very much upon local conditions, cost of lime, expense of handling and disposal of fouled material. Most gas companies prefer to wash, scrub and purify the gas free from all ammonia, tar and H_2S, thus removing at the same time all the CO_2, CS_2 and organic sulphur compounds possible; then enriching the gas, if necessary, rather than attempting to remove such a small per cent. of impurities at a great cost.

If the party asking this question will refer to the different papers on this subject read before the Gas Associations, or to the London Gas Referees for the Patterson scheme of lime and iron oxide purification, he can figure out a method to suit local conditions.

Fred Hauenstein:—Owing to our use of Kansas coal, it becomes imperative for us to employ some means for removing sulphur compounds other than H_2S from the gas. Sulphided lime is the only agent we have employed to effect this removal. The scheme of operation is as follows:

After the gas has been washed and scrubbed, it passes through a series of four oxide purifiers and four lime boxes, thence direct to the station meter. Assuming that the lime boxes are clean to begin with, the oxide purifiers and the first lime box of the series are by-passed, allowing the last three lime vessels to remove the CO_2 and H_2S. Owing to the comparatively large amount of H_2S present in the gas, the second lime box, as well as part of the third, quickly become sulphided. The fourth lime box serves as a check. When the H_2S begins to show at the middle of the third lime box, the oxide purifiers and the first lime box are then turned on. The oxide purifiers now remove the H_2S and the first lime box the CO_2, while the second and third lime boxes are in proper condition to take out the other sulphur compounds.

When the first lime box becomes carbonated it is renewed and placed last in the series, and the one that was second becomes first. The CO_2 coming into this box drives out the H_2S, which serves to sulphide the vessels on ahead. But owing to the fact that not all the H_2S is driven out by the CO_2, it becomes necessary to by-pass the oxide purifiers for two or three hours every time a lime box is renewed.

Our lime boxes are cleaned and renewed in rotation and the above method seems to be the best we have tried so far. At the time of changing boxes there are slight fluctuations in the amount of sulphur present in the purified gas, but since last November we have had very little cause for complaint.

H. B. Harrop:—English practice removes CS_2 with lime previously fouled by H_2S. Where reduction of CS_2 is imperative this foul lime method is satisfactory though it cannot be called cheap, and it requires a large investment, much experience, and careful handling, and entails the removal of CO_2 also. CS_2 can be removed with a solution of lead hydrate in caustic soda, but this is utterly impracticable on a working scale. Some CS_2 is removed in thorough scrubbing with ammonia liquor; compare my paper on "Gasworks Chemistry," Wisconsin Gas Association, 1904. Considerable CS_2 is absorbed in the boxes under certain conditions. See answer to No. 91.

No. 59. How is the amount of superheating surface in a Lowe water gas set determined, assuming that naphtha is the oil to be used?

Paul Doty:—In a general way the superheater area is estimated to balance the generator, viz.: when the generator fire is in the proper condition for gas making, the superheater brick shall be at the proper temperature for fixing the gas. The proper area has been arrived at largely by experiment.

Anonymous:—In best modern practice, the total surface of the combined check brick in carburetter and superheater (exclusive of the side walls of these shells), is about 28 square feet per gallon of oil used per hour. A part of this surface is excluded from direct contact with gas because of the contact of the bricks with one another; the brick surface directly exposed to the gas is about 20 square feet per gallon of oil used per hour. This is for even heavy oils. If any oil, as for instance naphtha, were being used which required less work in fixing, this would better be effected by changing the heat than by changing the amount of checker brick.

No. 60. What boiler horse-power would be required per million cubic feet of gas made per day, for a water gas plant and for a coal gas plant, respectively, of one, three and five million daily capacity?

Leonard Fitzgerald:—One hundred H. P. per million cubic feet of gas made is about the average boiler power needed, but all works should have at least two boilers and large works should have one extra in every five.

C. O. G. Miller:—References: Paper on "The Steam Consumption in a Water Gas Plant," read by Alten S. Miller at the 27th annual meeting of the American Gas Light Association, and published in the *American Gas Light Journal,* October 23rd, 1899, page 652.

Anonymous:—In the proceedings of the American Gas Light Association for 1899 will be found a paper on "Steam Consumption in a Water Gas Plant," prepared by Mr. Alten S. Miller. He states that the consumption of steam per 1,000 feet of gas made was 67.34 pounds, this including no steam for heating holders and plant. This is, in round figures, two boiler horse-power per 1,000 feet of gas made per hour. For works of the size specified in the question, the working boiler capacity required in winter would probably be, per 1,000 feet of maximum make per hour, for water gas works 2.5 horse-power, for coal gas works not using steam for stoking and conveying machinery 1.5 horse-power, and for coal gas plant requiring steam for stoking and conveying machinery 2 horse-power.

No. 61. What are the results of your experiments with machine cuttings from coal mines?

EDITOR:—I have been unable to locate anyone who has had experience in the use of machine cuttings from coal mines for the manufacture of gas. Many years ago certain capitalists proposed to utilize machine cuttings and other unmarketable products from certain Ohio mines for the manufacture of coal products. I did some engineering work for them, and from experiments made on these machine cuttings they should be as desirable for gas making purposes as any other fine coal. From the mines experimented on, the percentage of sulphur and other foreign matter contained was less than for an average sample throughout the thickness of the coal seam, as the cut was made through good coal. It is hard to quickly carbonize slack, as the heat does not readily pentrate it, but outside of the extra time and consumption of bench fuel it should make good gas, and from good coking coal should make coke fully equal if not superior to lump or run-of-mine coal. The fineness of much of this slack would insure a greater density of the coke made from it.

No. 62. Why do some gas engineers place the first scrubber between the tar extractor and the condenser, instead of placing the condenser between the tar extractor and the scrubber, as is the usual practice?

C. O. G. MILLER:—In California some engineers maintain in theory and practice that two scrubbers will displace a scrubber and condenser of approximately the same size, especially where heavy oil is used. As a condenser costs about three times as much as a scrubber of the same capacity, there is quite a saving in doing this. I have always supposed that the scrubber was sometimes placed before the condenser in order that less tar would be carried into the latter, also to partly cool the gas before it reaches the condenser.

EDITOR:—This question was in last year's Box, and was inspired by a constructing engineer regarding an installation made by the writer. This year he has sent a particular request that this question be answered. Lack of time prevents any extended consideration of this matter. Briefly, I may say this:

The arrangement secures the removal of a greater amount of sulphur, and as considerable heat is generated in the first washer due to chemical changes, it is sometimes necessary to remove this heat to enable the last washer or scrubber to do effective work in the removal of ammonia.

Later I will try to give a more extended description of the results obtained.

No. 63. Can anyone give a table showing the vapor-carrying capacity of blue water gas for benzol vapor at different temperatures?

A. B. Slater, Jr.:—The amount of benzol vapor that can be carried by the water gas will be but slightly less than that due to the normal vapor tension of benzol at different temperatures.

Robert Lindsey:—

Temperature. °C.	°F.	Tension Millimeters of Mercury.	Per cent. normal pressure.
-10	14	14.97	1.94
0	32	26.52	3.50
10	50	45.19	5.94
20	68	74.13	9.75

The table shows the percentage of benzene vapor retained by any gas or mixture of gases. All gases have the same vapor-carrying capacity. It is simply a matter of temperature and pressure.

Clarence S. Lomax:—I append a table (calculated from Landolt and Boernstein's tables) showing the amount of benzol vapor which blue water gas will carry at different temperatures:

°F.	% C_6H_6 (by volume).
-4	.76
5	1.16
14	1.70
23	2.41
32	3.34
42	4.48
50	5.95
59	7.75
68	9.95
77	12.62
86	15.85

H. B. Harrop:—The following table, showing the vapor tension of benzene is from determinations made in these laboratories (Milwaukee). The sample operated on was a "c. p. benzene" of the market, and was subsequently found to contain thiophene; the determinations were made hurriedly to supply data for a calculation; the truth is very closely approximated, however:

°F.	Mm.
20	18.2
30	24.0
40	31.5
50	43.4
60	60.1
70	82.7
80	115.3

To find the percentage of benzene, by volume, a gas like blue water gas will carry at any given temperature and standard atmospheric pressure, divide the vapor tension of benzene for that temperature by 790. Thus, at 60° F. the saturated gas would contain 60.1/760=.079, or 7.9% benzene.

No. 64. Will the vapor-carrying capacity of blue water gas for benzol vapor be reduced if gas is already saturated with water vapor?

A. B. Slater, Jr.:—The carrying capacity of blue water gas for benzol vapor will be but slightly, if any, reduced by the presence of a saturation of water vapor.

Robert Lindsey:—No. The pressure of the vapors retained in a gas which has been saturated by two immiscible liquids (such as benzene and water) is the sum of the vapor tensions of the benzene and water at the temperature at which the gas was saturated; so that blue gas saturated with water vapor would retain as much benzene as if there were no water present.

H. B. Harrop:—No. A very concise and easily comprehended statement of the principles involved in his interaction of suspended vapors will be found in second series, 1901, Question No. 8, of the "American Gas Light Association Course" papers.

Clarence S. Lomax:—Owing to the fact that benzol is almost insoluble in water (and water in benzol), there is almost no reduction in the amount of benzol vapor carried by blue water gas if the gas is saturated with water vapor.

No. 65. Has coal gas a greater affinity for water vapor than for benzol vapor?

A. B. **Slater, Jr.**:—If the word "affinity" means vapor-carrying capacity, would say that the carrying capacity of coal gas for water vapor and benzol vapor will be directly proportional to the relative vapor tensions, the vapor tension of benzol being very similar to that of water; that is, the curves are about the same shape and when plotted lie very close to each other, the benzol, however, having higher vapor tension for the same temperatures.

Robert Lindsey:—Coal gas would retain more benzene vapor than water vapor on account of its (the benzene's) higher vapor tension.

Clarence S. Lomax:—Coal gas has a far greater affinity, or rather solvent power, for benzol vapor than for water vapor.

H. B. **Harrop**:—Taking the tension of water vapor as 50° F. = 9.2 mm., 60° F. = 13.1 mm., 70° F. = 18.6 mm., compare answer to No. 63.

No. 66. Will blue water gas, carburetted with benzol vapor, drop any portion of this vapor to take up water vapor?

Robert Lindsey:—See answer to No. 64.

Clarence S. Lomax:—Blue water gas carburetted with benzol vapor will drop none of it on account of water vapor absorption.

H. B. **Harrop**:—See answers to 64 and 65.

A. B. **Slater, Jr.**:—Blue water gas is usually at saturation with water vapor, but not with benzol, and therefore would not drop any benzol to take up water vapor, nor would it even if the water vapor were not at saturation. To construct the curve of vapor tension of benzol, I may offer the following data, the curve to be constructed with ordinates of centimeters of mercury and abscissæ of degrees centrigrade:

°C.		°C.	
6	melting point.	80.4	boiling point.
10	4.5 cm.	90	101.5 cm.
20	7.6 cm.	100	134. cm.
30	12.1 cm.	110	172. cm.
40	18.4 cm.	120	224. cm.
50	27.1 cm.	130	283.5 cm.
60	39.1 cm.	140	353. cm.
70	54.7 cm.	150	434. cm.
80	75.4 cm.	160	523. cm.

(See Schaar's Chemiker Kalendar.)

With this table I may quote from a paper on coal gas treatment, which I read some time ago, as follows: "As we have a mixture of vapors to deal with, it is well to note that the partial tension of each component of the mixture is always slightly less than the amount of its respective vapor tension when alone at the same temperature and pressure. With this qualification, Dalton's law of vapor tensions holds practically good for our range of temperatures; that is, in a space already occupied by a gas, a liquid ultimately evaporates to the same extent as in vacuo, the process being merely more slow."

No. 67. How can furnace fuel be saved in coal-gas benches, other than by regenerative methods?

JAMES W. DUNBAR:—See answer to No. 55.

FRANK N. DAVIS:—Tap bench flue at lowest point, carry waste gases under steam boiler, and 20 per cent. of the fuel in the furnace will be saved, and at the same time give a higher heat on the bench, providing there is a chimney to produce a fair draught. A single bench will produce from 5 to 10 horse-power from the steam thus made. Have had fine success in this line for 22 years.

No. 68. What is the best and most efficient method of setting a plain coal gas-bench of 5 or 6 retorts?

E. J. CURLEY:—In our plain settings of 6's the retorts are 16" x 26" x 9', and carbonize 416 lbs. of coal in 6 hours. These retorts are 2 wide and 3 high, and are constantly maintained at a temperature sufficiently high to produce 4.70 cubic feet of gas per pound of coal. Choked stand-pipes are almost an unknown quantity; naphthalene depositions in general hardly appreciable, and at the works, none. These retorts are built in such a manner that all the heat from the furnace rises and passes to the rear end of bench, then comes forward to the front, passes down to and under bottom retorts, then to the rear end and to the stack. The nostrils, or spaces, between the saddle tiles, upon which the middle and upper retorts rest, are closed tightly except the rear one, which is left open; about 15 inches space between last saddle tile and rear wall of bench. This latter is the only exit the heat has for eventually reaching the stack. So it can be readily seen that the interior of the bench receives all the heat, and also that the absence of flame in our stacks is indicative of that which is most essential—perfect combustion.

HENRY I. LEA:—I should say a bridge-way setting for a plain bench of five or six retorts gives most satisfactory results.

No. 69. Should flame be permitted to come out of gas bench stack?

E. J. Curley:—Should not, under any consideration, for the presence of such indicates partial combustion of the fuel with a consequent loss of caloric.

Walter M. Blinks:—This is an indication that something is wrong, and usually is caused by leaks in the retorts permitting gas to escape into furnaces. In the proper working of regenerative furnaces no flame should appear even at base of stack.

Henry I. Lea:—This reply is dependent on the fuel being used in benches, as there has, as yet, been no practicable scheme developed for the complete combustion of the large quantity of gas thrown off immediately after filling with coal. With a coke fire, the matter is very much simplified, and there should be no flame at the top of the stack.

E. J. Sherwood:—No flame should be permitted to come out of a gas bench stack when coke is used for fuel, but when coal is used a small flame is permissible, as a small amount of under-ventilation is necessary when the furnaces are freshly fired in order not to give too much over-ventilation after the hydrocarbons have been burned off from the coal.

John Gimper:—No.

J. Wallace Schaefer:—Flame should not be permitted to issue from gas bench stack. When it does show it indicates an insufficient supply of secondary air.

E. M. Osbourne:—No. The gases should be turned inside bench.

Alex. Wyness, Jr.:—Never, if possible. Shows that there must be some leak in retorts or waste of heat.

No. 70. What is the smallest percentage of coke drawn (or pounds to 100 pounds of coal carbonized) sufficient to run a plain-set bench of 5 or 6 retorts?

B. O. Tippy:—We had in the year 1902 a number of plain set benches of 5's and 6's in use in Detroit. These benches were small and of poor design for fuel economy. We used under these benches about 40 per cent. of the coke drawn, or 520 pounds per ton of coal carbonized. For years in Grand Rapids we ran plain set benches of 6's on 30 to 33 per cent. of coke drawn.

E. J. Curley:—We have the plain settings of 5's and 6's, designed and erected under the supervision of my father, Thomas

Curley, and on repeated tests (using cold, drenched coke), we have varied from 14.5 to 16 lbs. of coke per 100 lbs. of coal carbonized, or its equivalent, 23.5 to 24 per cent.

J. H. Hagerty:—When the bench and setting are in good condition 25 per cent.; otherwise 33 to 50 per cent. of the coke drawn.

Paul Doty:—Thirty per cent. of coke drawn, or 20 lbs. to the 100 lbs. coal carbonized, are results that have been obtained in running plain settings of 6's.

No. 71. Why should oxide for purification be dampened before using?

James W. Dunbar:—Because oxide of iron and sulphuretted hydrogen mutually react on each other in the presence of moisture better than when the oxide is dry; why it does so is not known.

M. E. Malone:—"The presence of a very small amount of moisture makes the oxide effective. Perfectly dry oxide will not combine with sulphuretted hydrogen." Moisture or dampness causes the particles of iron to adhere to the sawdust, chips or other material used, thus preventing the oxide from wasting by running through the trays.

No. 72. Which is the best kind of wheelbarrow to use about a gas works, wood or iron (except for hot coke)?

H. H. Ganser:—We use both wood and iron barrows and find the wood barows outlast the iron and cost very little to repair. Where the body of the iron barrow is bolted to the running-gears, it soon gives out whether it be a slide or end-dumper.

A. F. Reitemeyer:—Iron.

E. M. Osbourne:—Iron is more durable and seems best liked by the men.

Alex. Wyness, Jr.:—Iron for all general purposes.

No. 73. Why can't a bucket or belt conveyor be used to elevate water-gas generator fuel, instead of an expensive elevator?

W. T. Thecker:—Why not? As a mechanical problem it is not difficult.

A modification of the conveyor built by the writer at Easton, Pa., for raising oxide purifying material to a revivifying floor above the purifying house, could easily be devised and would be about as follows:

An endless belt of about 10 inches face, having screwed to it oaken cleats 3 inches high, and 1 foot apart, and carried on two pulleys 20 inches in diameter, which would be supported by necessary frame work placed at an angle of 65 degrees and operated by motor. Under the upward traveling side of the belt would be a table reaching from one pulley to the other to keep material conveyed from falling into the belt. Between this table and the belt would be placed 2-inch wooden rollers 4 feet apart, to support the loaded belt and keep it from dragging on the table. The whole should be enclosed, if outside the generator house, to protect belt, etc., from the weather. The side boards of the enclosure should be as close to the belt as possible.

A 36-inch pulley outside the casing at the upper end would receive power from the motor which would be located at "A."

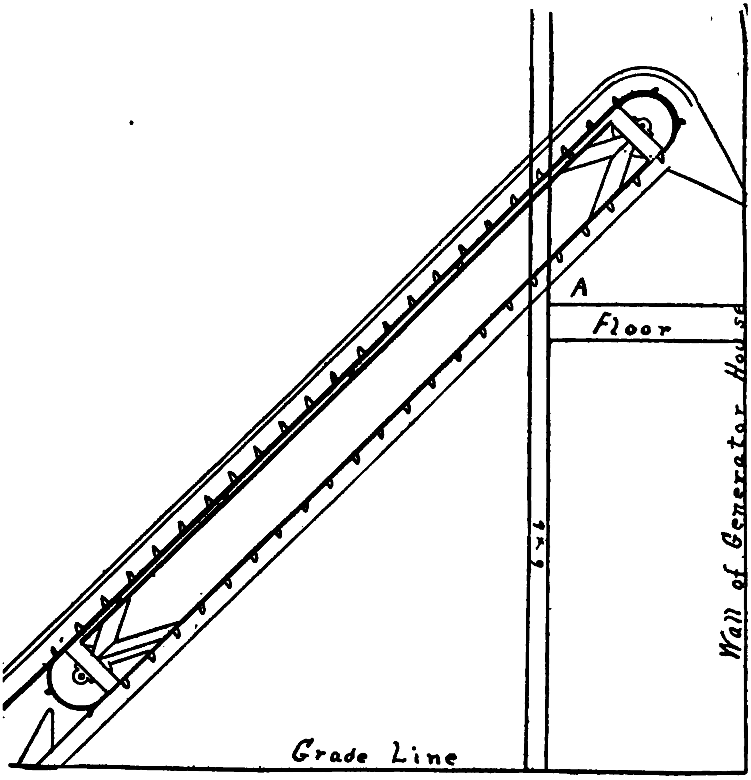


FIG. VIII.

The framing should be outside the casing so as to bring latter close to pulleys and belt. All parts of casing should be so put together that access can be gotten to any part in case of necessity.

The cost of conveyor, including everything except the motor, would not be more than $125.00.

Sketch herewith gives no details, but only a rough outline.

A. I. Payne:—To my own knowledge and experience there are several carburetted water gas plants, using coke as fuel, equipped with bucket elevators for handling generator fuel, all of which are working more or less successfully. Some are used, in conjunction with conveyors, storage hoppers, and measuring chambers, these latter discharging by means of a chute directly into generators. Others discharge into store from which fuel is loaded in usual wagons by hand.

In general a reduction of the efficiency of the generator (both in capacity and fuel economy) usually follows their adoption. The cause of decreased capacity is due to fuel being reduced in size, causing lengthened blowing periods. Decreased fuel efficiency is due to loss of fuel that is reduced to a fine state.

Henry I. Lea:—There is no reason why a bucket or belt conveyor cannot be used to elevate generator fuel, provided of course that there is no unusual breakage of lumps involved. Ordinarily, gas-house coke is perhaps the most friable of the generator fuels, but I have experienced no trouble whatever in handling this with a bucket elevator, similar to the Jeffrey link bucket. Although a certain percentage of coke breeze can be used in the generator, the conveyor used should be determined on largely by consideration of the quantity of breeze produced in handling.

No. 74. Is it advisable to use a steam regulator or reducer on the steam line to an exhauster?

H. L. Rice:—A reducing valve maintaining steady steam pressure is being successfully and advantageously used on the main steam line to the exhauster at Norfolk, Va. See Wrinkle Department.

J. H. Hagerty:—Under ordinary conditions of operation it is not necessary, but where there is considerable fluctuation in the steam pressure it might be desirable to place a regulator in the line near the engine. An arrangement of this kind would help the engine regulation by giving the governor less work to do, and would probable correct any tendency the engine might have to race.

F. TOBEY, JR.:—We ran a McKenzie exhauster with a Curtis reducing valve (from 120 to 50 pounds) for six or seven years at our works without thaving any serious difficulty with it.

No. 75. What is the cheapest way to paint a gas holder?

H. H. GANSER:—We put a good quality of a heavy mineral oil in the cup of one of our two-lift holders to keep the same from rusting away, and found that in uncupping, a small quantity each time ran down over the sheets, making a very good paint. The upper lift of the same holder is covered with a mixture of tar, air-slaked lime and oil.

A. F. REITEMEYER:—Coal tar; lasts longer and preserves iron better than any paint manufactured.

JOHN J. POWER:—The cheapest way to paint a gas holder is to use the best quality of paint thoroughly rubbed in with a brush after the surface of the metal has been well cleaned. I have found good graphite paint the best, and the best is the cheapest.

F. W. STONE:—At one of our works we have a holder that was built in 1877, which has been painted with nothing else than coal tar, the coal tar having been heated and a little lime stirred in to cut the acid. I cannot say that this holder, to-day, is as good as new, but it is in very good working condition, and what rust or weakness has appeared seems to come from the inside, and not from corrosion on the outside of the holder.

J. H. ENRIGHT:—Coal tar, when sufficiently heated to throw off all ammonia, and properly applied, makes a very cheap and serviceable paint for a holder.

E. M. OSBOURNE:—Consider graphite best paint for the purpose. We used a cheap grade of graphite paint last, and find it stands against action of water in holder pit, spreads easily and over a large territory. All loose paint should be removed, leaks calked and shellacked. Large holders can be painted while on the rise. Have seen a four and a half million holder painted in a day.

M. T. WALKER:—Coal tar boiled until it will barely string, mixed with one-tenth part benzene, makes a good hard paint for a gas holder.

No. 76. In settings of the recuperative type, in which the furnaces are charged with hot coke in front, and in which also the fires are clinkered and cleaned at the back of each setting, what is the best way to secure uniformity of heat, where the back ends of the retorts become excessively hot when the front ends of the retorts are raised to the proper temperatures?

HENRY I. LEA:—The difficulty complained of here would indicate improper proportions in the nostrils of the bench, or partial stoppage of some of the nostrils. If, when properly adjusted, the dampers will not secure equality of heats, I would suggest a partial closing of the nostrils at the rear of the bench by dampers of special fire brick or tile, as the case might demand. This remedy could be applied in nearly all benches without interfering with operation.

M. E. MALONE:—Plug up one or more of the nostril holes in rear of arch, thus forcing the gases from the producer to escape and be consumed in the combustion chamber nearer the front of the bench.

No. 77. What is the best remedy for preventing choked standpipes, and the formation of pitch in the hydraulic main, it having from three-fourths to one-inch seal, the heats being only sufficient to produce a yield varying from 4.9 to 5 feet per lb. of coal, and about 8,500 feet per retort in 24 hours? (Size of retorts 16"x26"x10'.)

V. F. DEWEY:—Reaming stand-pipes one hour before drawing charge will prevent choked stand-pipes.

M. E. MALONE:—Reduce the seal on dip pipes and increase the size of the charges, which will not only give an increased make, but prevent the troubles complained of.

HENRY I. LEA:—The formation of pitch in the hydraulic main, I should say is best remedied by increasing the rate of flow of gas over and through the body of coke in the retort. I have frequently found that increasing the furnace heat and at the same time decreasing the retort heat, by placing the retorts under heavier working load, has overcome this trouble. In some instances, the formation of naphthalene was apparently being caused by the same conditions that yield lamp-black.

No. 78. What is the best roof for a retort house? If slate, what is the best way of fastening it on?

M. E. MULHOLLAND:—The Springfield Gas Light Company of Springfield, Ohio, have carefully gone over the matter of roofing for the large works that are at present being constructed, and have adopted a tile roofing made at Lima, Ohio; their test showing that this roof, made so dense by being compressed under 15,000 pounds pressure, is practically indestructible, will not crack or break, and is not affected by fumes from the retort house. The construction of these tile shingles is such as to permit of their being hooked over the angle irons, or fastened to same by a copper wire.

The Springfield Company is very enthusiastic over the material, and predict that now that it has been found possible to purchase a practical tile roof at a price no greater than slate, the question of roofing for retort houses has been settled.

A. F. REITEMEYER:—Slate; copper wire.

JOHN J. POWER:—My experience has been that slate roof, fastened with lead nails or ties, is the best roof for a retort house.

ALTON LIGHT & TRACTION CO.:—We fasten slate by means of copper wire. The roof on our old retort house, which was torn down in 1901, had its slates so fastened, and was found in good condition after fifteen years' use.

No. 79. Which will give the best fuel economy, regenerative benches of 8's (2 wide, 4 high), or benches of 9's (3 wide, 3 high)?

PAUL DOTY:—Regenerative benches of 8's show practically the same fuel economy obtained from best type of regenerative benches of 9's; that is, the pounds of bench fuel used for each type are the same, approximately. Both use 300 to 320 pounds of bench fuel per ton of coal carbonized.

No. 80. How long will the center bottom retort of a bench of 9's last? Will the narrow arch for 8's last longer than the wide arch of 9's?

HOWARD E. MANN:—In our benches of 9's the center bottom retort has lasted as long as the other eight; from 1,200 to 1,400 days (actual working days).

PAUL DOTY:—It is expected (in Detroit) that the arch for the 8's will last as long, at least, as an arch designed for full-depth 6's, the nature of the setting being practically the same. The writer knows of settings of 9's where the center bottom retort did not last to exceed six months. It is believed the narrow arch in the 8's, having no weight to support, will last much longer than the arch in the 9's.

HENRY S. WHIPPLE:—We have two benches of 9's in use, making over 10,000 feet per mouthpiece, that have been in use continuously since December 1st, 1900.

No. 81. What is the best form of damper for stopping draft when clinkering a coal-gas bench?

H. H. GANSER:—We have stacks on our benches about 12 inches in diameter, and use a plate about 14 inches in diameter suspended from a lever rigged in an arm which extends above the top of the stacks about 16 inches. To the end of the lever is attached a chain which is carried through pulleys to the retort house, and hooks are placed on the wall opposite to the front of the benches, by which one can regulate draft as well as cut off draft entirely while clinkering.

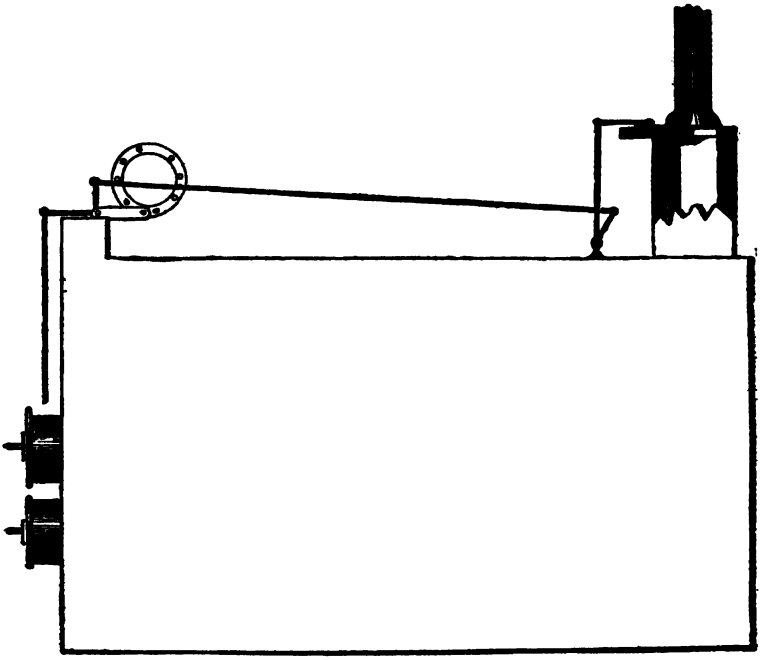


FIG. IX.

E. J. Curley:—The accompanying sketch illustrates a very convenient arrangement for a stack damper.

Henry I. Lea:—The fire clay tile, reinforced with inlaid irons, makes a very satisfactory damper for this purpose.

No. 82. Is there any practical method of temporarily increasing the secondary air supply to accomplish combustion of the large volumes of hydrocarbons and carbon monoxide produced in the early part of each stoking period in a coal-fired bench?

Walter M. Blinks:—Many gas works now are provided with compressed air for operating elevators, hoist, etc. This could easily be introduced into secondary air flues and supply increased at will of operator.

Henry I. Lea:—As far as I can learn, no one has yet overcome this objection to coal firing. I can see no reason, however, why forced draft might not be applied to a stack of benches with several advantages. One of them would be the ready control of excess air required just after the coal charge.

No. 83. Assuming that the fuel contains no combustible but carbon, a chimney gas analysis may be checked or "proved" by adding together the weights of the oxygen in the free form, as CO, and CO_2, and comparing with the known percentage by weight of oxygen in the air. Can this be done without reducing the results of the volumetric analysis to weight?

E. E. Eysenbach:—It can be checked up by volume as well as by weight.

Donald Davidson:—Yes. Per cent. vol. CO_2 + per cent. vol. O + ½ per cent. vol. CO should equal 20.8.

E. J. Sherwood:—When the fuel used contains no combustible but carbon, a chimney gas analysis may be checked without reducing the results of the volumetric analysis to weight. This is found by using the volumes of the CO_2, O and CO as a basis to figure from. For example, suppose an analysis shows 15 per cent. of the CO_2, 4 per cent. of oxygen and also 4 per cent. of CO. The nitrogen in the flue gas is the difference between 100 and the sum of the CO_2, O and CO, 23, which gives 77.

The 15 per cent. of CO_2 represents 15 per cent. of oxygen in the air before combustion; the 4 per cent. of oxygen represents 4 per cent. of oxygen in the air before combustion; the 4 per cent.

of CO represents 2 per cent. of oxygen in the air before combustion, making a total of 21 per cent. oxygen in the air before combustion.

Now, the proportion of oxygen to nitrogen by volume in the air is 21 to 79, or 1 to 3.761. Therefore $21 \times 3.761 = 78.981$ per cent., which is the volume of the nitrogen which should be present in the flue gas instead of 77 as shown by the test. As these results do not check, the analysis should be repeated.

The relation that the oxygen in the air before combustion bears to the CO_2 and CO produced is easily deduced from Avogadro's Law, which is that equal volumes of all gases and vapors contain the same number of molecules at the same temperature and pressure; that is to say, that the volume of one molecule of a gas is the same as the volume of one molecule of any other gas at the same temperature and pressure. Therefore a molecule of CO_2 is of the same volume as the molecule of oxygen that combines with carbon to form the CO_2. Hence 1 per cent of CO_2 in the flue gas represents 1 per cent. of oxygen in the air before combustion.

When CO_2 is acted upon by C, we have $CO_2 + C = 2CO$. By the same law, one volume of CO_2 produces two volumes of CO or ½ volume of CO_2 produces one volume of CO; and as one volume of oxygen produces one volume of CO_2, therefore 1 per cent. of CO in the flue gas represents ½ per cent. of oxygen in the air before combustion.

H. B. Harrop:—If the fuel contains no combustible but carbon, and no volatile matter, and the chimney gas is found to contain no CO, the sum of the volume percentages of O_2 and CO_2 found in the chimney gas should exactly equal the volume percentage of O_2 in the air supplied the fire, or about 21 per cent. If the fuel contains water, oxygen, or nitrogen, or if water is used in the ash pan, even the rule for *percentage by weight,* as commonly published, cannot be used to check.

No. 84. When the fuel contains appreciable quantities of hydrogen, as in a newly-stoked coke-fired bench, or at all times in a coke-fired bench, the analysis cannot be "proved" by the method noted in the last question. Is there any way of doing it?

H. B. Harrop:—If, as in an ordinary coke-fired bench, with water in the ash pan, the chimney gas is found to contain no CO, H_2, or hydrocarbons, the following rule can be used for a check:

The free O_2 found indicates the volume of excess air ($O_2 + aN_2$). N_2 found, less N_2 calculated from O_2 found, is 79/100 (79%) of air consumed by fuel. From this air calculate O_2 consumed. Deduct from this O_2, the O_2 in the CO_2 found (or simply deduct the volume of CO_2 found). From the remaining O_2 calculate the H_2 in combination.

This is not so complicated as it seems. It also affords a direct means of examining chimney products in a furnace fired by illuminating gas, and thus—or by combustion in a Drehschmidt—makes easy the "ultimate" analysis of illuminating gas.

No. 85. Is there any quicker method of determining total sulphur in coal than the Eschka?

HOWARD E. MANN:—Yes, by the use of peroxide of sodium, Na_2O_2, as an oxidizing agent and then proceeding by the regular gravimetric determination for SO_3.

H. B. HARROP:—In Jour. Am. Chem. Soc. for February, 1903, there was a paper by Sundstrom (marked, received November 26th, 1902), giving a quick combustion of sodium peroxide in a special cartridge. Prior to this I had used the cartridge of the Parr calorimeter and sodium peroxide for this purpose, and had a paper before the McMillin Company Managers' Association, read at the New York meeting on October 14th, 1902, in which the method was fully described. This process, which is now generally known as the Sundstrom method, has recently been modified by Pennock and Morton (Jour. Am. Ch. Soc., December, 1903), by combining with it the Andrews titration scheme for estimating the sulphuric acid found. This volumetric modification is of dubious merit, but the peroxide combustion is a vast improvement over the Aschka.

W. B. CALKINS:—The old-fashioned method is a method in common use for the determination of total surphur in coal and coke and is somewhat quicker than the regular Eschka's method, but must be watched more closely at the start. It consists of fusing up 1 gram of the coal or coke sample with about 9 grams of sodium carbonate and 5 grams of potassium nitrate. A full description of this method can be found in any good quantitative text-book. A rapid method for the determination of sulphur in coal and coke is described in the *American Gas Light Journal* of January 11, 1904.

Donald Davidson:—See "A Rapid Method for the Determination of Sulphur in Coal and Coke," by Pennock and Morton, ***American Gas Light Journal*** of January 11, 1904.

No. 86. When the amount of sulphur left in the coke is of no consequence to the gas company, why is it not the only proper test to subject the coal sample to distillation on a small scale, but under conditions similar to retorting in regular practice, and determine the sulphur in the volatile matter?

Paul Doty:—There is no objection to this method, if the amount of sulphur left in the coke is of no consequence. But as a matter of fact the amount of sulphur left in the coke is of very great importance to a large majority of purposes for which coke is used, viz.: in water gas generators, the heating of iron, steel, etc., and also domestic purposes.

No. 87. Besides the two obvious expedients of frequent steaming, and more gradual cooling by the use of extra condensers, is there any way to prevent the accumulation of quantities of ammonium carbonate in the water condensers of a coal gas condensing system?

No. 88. In average good practice, what fraction of a pound of ammonia per 1,000 feet of gas is found to escape the scrubbers?

Howard E. Mann:—In good practice, 5 to 6 grains per 100 cubic feet to keep the purifying boxes alkaline.

Paul Doty:—In good practice practically no ammonia is allowed to escape the scrubbers. Some ammonia, however, is held in suspension in the tar of the hydraulic main and never reaches the scrubbers.

No. 89. From the reaction $FeSO_4\,7H_2O + CaO$, etc., it seems that 1/5 lb. quick lime will convert 1 lb. copperas into ferrous oxide. Why do most of the formulae used in gas works prescribe 1, 2 and sometimes 3 lbs. quick lime to one of copperas? Is this lime intended to fulfill any other purpose than to convert the iron of the copperas into a form where it will readily absorb H_2S?

HOWARD E. MANN:—To keep the purifying boxes alkaline, so as to absorb as much of the CS_2 as possible. The compound of iron formed is primarily the ferrous hydrate which is readily transformed into the ferric hydrate.

PAUL DOTY:—It is found in practice that hydrated iron oxide should be in an alkaline condition for most effective absorption of H_2S. The excess lime tends to maintain this alkaline condition.

No. 90. To what extent is lime purification (for CO_2) used in this country? Foul lime (for CS_2)?

No. 91. What are the conditions governing the absorption of CS_2 by foul oxide—in terms of age, sulphur content, percentage of moisture, time, etc.?

H. B. HARROP:—From experiments in Milwaukee's East Side works I have concluded that the CS_2 absorbed in the boxes decreased with the temperature and the moisture, and increased with the amount of H_2S, the amount of air, the length of time allowed for revivification, the total amount of sulphur in all the boxes, and especially with the amount of sulphur in the first box, and with the frequency of revivification.

One test lasting forty-eight hours indicated an absorption of 56 per cent. of the CS_2 entering the boxes. It should be stated that this material was frequently revivified *in situ* by the "steaming method"—air drawn through the idle boxes by means of a steam siphon.

No. 92. What is the source of the ammonia which sometimes appears in water gas purifying boxes?

E. J. SHERWOOD:—Where the water gas machine is not thoroughly purged when each run is put on, a small amount of air may be left in the machine. The nitrogen in this air would combine with the nascent hydrogen produced in the generator, and the product would be NH_3. Free hydrogen will combine with nitrogen when the temperature is high enough, as it is in the water gas apparatus. This fact may be found in any advanced chemistry, as Remsen's.

HENRY I. LEA:—Inasmuch as a considerable proportion of the total ammonia in coal remains in the coke, I should say the ammonia here referred to may be traced to this source.

No. 93. To avoid frequently dismantling and cleaning the take-off pipe of a Lowe water gas set, would it be practicable to make such changes as would carry the blast through this pipe, instead of directly from the superheater through the roof?

E. J. Sherwood:—It is practicable to carry the blast through the take-off pipe, provided that the operation is performed often, as there is considerable danger of overheating the pipe if too large an amount of carbon is allowed to accumulate.

M. E. Malone:—The scheme is practicable, but too expensive. It has been tried on a Springer set, and while keeping the take-off pipes perfectly clean, the intense heat produced caused the pipes to warp and crack, necessitating their renewal twice during a period of less than a year.

No. 94. Why cannot hard clinkers be prevented in a water gas generator by admitting a small percentage of steam with each blast? And can sufficient steam be used to accomplish this result in actual practice without upsetting the heat equations?

Paul Doty:—The objection to this plan is that the steam would be decomposed, forming combustible gas, and thus defeat the object of cooling the clinker.

No. 95. What is the value of 45° crude benzol as an enricher for coal gas compared with crude naphtha and distillate?

W. M. Sites:—A paper by Mr. A. Lecomte, of Paris, published in the *Amercan Gas Light Journal* of July 28th, 1902, page 110, will perhaps throw some light on this question.

No. 96. Can anyone give an actual experience with isolated generators in relation to coal gas bench work?

No. 97. Can anyone give actual experience in the operation of any power plant, whether in a gas works or electric station, by means of producer gas?

No. 98. What is the most successful and economical producer on the market to-day? What is the essential principle which determines its economy?

Paul Doty:—The Pintsch producer, which will be on exhibition at the St. Louis fair, is one of the highest types of producers for gas engine work.

No. 99. Is there any reason why a producer should not be run at the highest possible tension, that is, at an extremely high blast pressure if clinkering can be prevented?

No. 100. How could such clinkering be prevented, and what effect would such high tension running have upon the capacity per unit of area or unit of mass of the producer?

A 1. What effect would such high tension running have upon the total efficiency of the producer as compared to low tension running?

A 2. What kind of fuel is best adapted, in general, for producer gas work?

PAUL DOTY:—The smaller sizes of anthracite coal.

A 3. Is naphthalene formed anywhere but in the retorts?

W. B. CALKINS:—Naphthalene is formed by the action of heat on organic substances, but only at rather high temperatures. Tar that is formed at low heat does not contain it at all, and the only place where it could be formed in gas making is in the retorts.

JOHN GIMPER:—If the question refers to coal gas alone, the answer is naphthalene is formed in retorts only.

E. J. SHERWOOD:—Naphthalene can be formed in a water gas machine if too high heats are carried in the superheater.

J. CHAS. ANDREWS:—References: Paper on "Formation of Naphthalene," by Paul Doty, read before the twenty-second annual meeting of the Western Gas Association, and published in the *American Gas Light Journal,* June 26th, 1899, page 267; discussion published in the *American Gas Light Journal,* July 3rd, 1899, page 2.

A 4. Why does no explosion take place when the seal in hydraulic main is broken, and exhauster is taking a vacuum of 2 inches, and a fire at end of stand-pipe? If no explosion takes place under above conditions, why are we so careful of a dead main as to fire?

WALTER M. BLINKS:—There must be a considerable surplus of air to produce an explosive mixture of gas, and there is much more chance of such a mixture in a dead main. One takes a long chance in permitting any mixtures of gas and air to occur in proximity to flame.

E. J. SHERWOOD:—There is probably not a sufficient supply of oxygen to allow combustion to travel up the standpipe farther than a few feet. The gas and products of combustion traveling up the standpipe put the flame out, unless enough oxygen can be taken along to produce combustion. A dead main, when exposed to the air, tends to empty itself of the gas, as the gas is lighter than the air and has a tendency to rise. After a certain amount of the gas has been displaced by the air, the main contains an explosive mixture. There can be no explosion without a proper mixture, no matter whether a fire is present or not.

A 5. What would you do if called hurriedly to works to find over half the water in commercial holder gone, and the balance rushing down the valley below works, and no other holder to fall back upon (water being held in by masonry)?

HENRY I. LEA:—Assuming that a large crack had suddenly developed in the masonry I should arrange to place paper sacks, containing finely broken lime, in, or directly in front of, this crack on the inside. The paper must, of course, be rather tough, and a special device be used in lowering the sack and releasing it at the proper point. The bag should then be broken open and the water, on going through the crack, will wash the lime in and gradually the lime will lodge and swell, thus closing the crack temporarily. If the cracks are but small, this may be used as a permanent remedy.

Supposing that a large stone has in some way been released and a column of water is gushing through, I should lower a heavy screen, covered with coarse canvas (the canvas itself being cemented between layers), down on the inside of the tank until directly over the opening. In this way, the leak could be stopped temporarily while repairs could be made from the outside. It might be found necessary to brace the refilling from the outside, until the cement had thoroughly set.

A 6. How may we best decide the time, economy on all sides considered at which it becomes unprofitable to run a bench before shutting down for repairs?

PAUL DOTY:—The proper time to shut down a bench for repairs is when the cost of maintenance becomes more than the rate of depreciation of a new setting.

J. H. HAGERTY:—Whenever the loss occasioned by leakage, falling off in capacity, and excess of fuel required is sufficient to pay for the repairs or renewals in about one year.

A 7. Would the constant jarring of heavy trains, where gas holder is situated near the tracks, be injurious to the masonry of holder, thus causing it to leak? What could be done to stop the leak?

WALTER M. BLINKS:—The writer knows of two brick holder tanks that have stood for 10 and 20 years respectively within fifty feet of two main lines of railroad upon which heavy trains are constantly passing at high speed. The masonry is uninjured and tanks perfectly tight. The soil is sandy, but subject to considerable jar, as in excavating for last tank built a cave-in occurred nearly every time a train passed.

F. C. WEBBER:—I do not think the jarring of trains would affect the masonry of the holder tank. Our holder tank, consisting of a brick wall cemented, is so situated that there is a railroad track about 4 feet from one side of the tank and another about 20 feet from the other side, and these tracks are in daily use and have been for a number of years. About five years ago we had occasion to empty our holder tank, and we could find no leaks in the cement which would come from this cause. At the time we recemented our tank and have had no leakage to speak of since.

Our tank was in pretty bad shape at that time, before we recemented it, and we used sawdust, bran and horse manure with varying success for stopping the leakage, and finally came to the conclusion that about the only sure way to stop this leakage was to empty the tank and recement it, which we did.

A 8. How many months' supply of coal should be stored at a gas works as a safeguard against coal strikes, which of late have been alarming frequent?

E. J. CURLEY:—Have storage shed completely filled, then have shipments arranged so that you can receive daily what you carbonize.

B. O. TIPPY:—It depends upon relative water gas and coal gas capacity of plant. Enough coal should be carried in stock to supply the city with gas for three months with the water gas plant running at full capacity. Balance of gas required by the city to be coal gas.

A 9. How much gas can be accurately measured by a station meter beyond its rated capacity?

E. J. CURLEY:—Would not care to go over 10 to 15 per cent.

A. F. REITEMEYER:—Thirty-five per cent.

B. O. TIPPY:—It is my opinion that a station meter will register accurately until gas blows through seal between the inlet and outlet compartments of meter, or in other words, until the differential pressure of the inlet and outlet of meter equals the seal between the inlet and outlet compartments of the meter.

A 10. What holder capacity would you recommend for a plant sending out five hundred thousand cubic feet per day? What is the basis used by engineers for figuring the holder capacity of plants of a given capacity?

PAUL DOTY:—In a small-sized works the output and the storage capacity should be in the ratio of 1 to 1. In large works this ratio may be decreased. There are works in this country with the ratio of output to storage capacity as low as 2 to 1.

J. J. KNIGHT:—If the plant is all coal gas, the storage capacity should equal the average daily output during the months of November and December.

If a water gas plant, I should think the storage capacity could be much less with safety. In either case, much would depend upon the generating capacity. It is wise to have more than one holder in any case, and all machinery about a gas plant should be in duplicate in order to be very comfortable.

W. W. FROST:—Holder capacity should never be less than the maximum daily send-out.

A 11. How much oil storage should be provided for in plants of five hundred thousand cubic feet, one million cubic feet, one million five hundred thousand cubic feet and two million cubic feet daily capacity, respectively, in towns located 500 miles from the source of supply and making water gas exclusively? What is your basis of estimate?

F. Tobey, Jr.:—Depends somewhat upon candle power of gas manufactured. Storage should not be less than two weeks' supply.

Paul Doty:—Estimating that 5 gallons of oil are required per 1,000 cubic feet gas made, and that there should be storage capacity for 30 days' supply, a plant of 500,000 cubic feet daily capacity should have storage capacity for 75,000 gallons oil; 1,000,000 cubic feet daily capacity should have storage capacity for 150,000 gallons oil; 1,500,000 cubic feet daily capacity should have storage capacity for 225,000 gallons oil; 2,000,000 cubic feet daily capacity should have storage for 300,000 gallons oil.

A 12. What is the smallest producer plant practical for the operation of gas engines in a manufacturing plant?

Paul Doty:—The labor cost per thousand cubic feet of gas would determine this question. A plant of 50,000 cubic feet daily capacity would be about the smallest practicable.

A 13. Why are the recuperator flues hotter at times when there is no apparent fluctuation in the heat of the retorts and with no alteration in the stack temperatures?

A 14. When it is necessary to shut down a water gas set for one hour, on account of holders being full of any other cause, what would be the approximate loss in generator fuel for different sized apparatus occasioned by such shut-down?

Paul Doty:—Fifty lbs. coal per hour would be the approximate loss in generator fuel in medium sized sets for occasional shut-downs.

Thomas Hood—1889.

J. W. R. Cline—1895.

Emerson McMillin—1887.

Joseph Gwynn—1896.

Jerome Penn—1897.

DISTRIBUTION.

No. 101. Is it customary to compel gas companies to refill their trenches with gravel when a trench or a cut for a service is put under an asphalt pavement?

Henry S. Whipple:—We have to fill the trench with concrete.

Philo Jones:—After stamping the dirt, which has been removed, back into place, our city ordinance requires us to fill in six inches of rock and concrete before laying the asphalt pavement, even though there was nothing but rock and gravel previously.

W. E. Hartman:—Not in Norfolk, Va.

Alton Light & Traction Co.:—The ordinance of our city requires that all trenches be filled with sand.

Walton Forstall:—In Philadelphia, there is no obligation as to the character of the refill under asphalt pavement, and it is our custom to put back the material we take out, except only rock or ashes, for either of which good earth would be substituted. In the matter of base for asphalt paving, we have decided that concrete is always preferable, and our contract for asphalt repairs calls for concrete base even in streets laid with bituminous base.

J. H. Enright:—It should be customary, as well as very good business policy, for a gas company to put all openings made in streets and alleys in as good condition as they find them.

Where openings are made in paved streets and alleys, I believe it to be commendable on the part of city governments to see that all trenches are filled and finished in good substantial order.

Frank Hellen:—We are not compelled to refill with gravel. Our work in the public streets is under supervision of the department of public works. If the tunnel cannot be properly filled with the earth removed from the excavation, we are compelled to knock down the arch of the tunnel and refill from the top. In tunneling we are careful to keep as thick an arch of dirt under concrete as possible, for if tunnel is too near the concrete, the pavement will settle easily and the arch will have to be broken down and refilled from the top.

B. F. Bullock:—Not in any place I have ever been.

B. C. Cobb:—It is customary to fill trenches with river sand, gravel and concrete.

No. 102. Is it wise to ever use 2-inch wrought iron pipes for mains?

J. H. NELSON:—It is never wise to use 2-inch pipe for mains, as they are too small.

C. W. BENNETT:—In some cases I have found it wise to use 2-inch wrought iron pipes for mains. But as a rule, I think it is not.

E. J. CURLEY:—No.

J. J. KNIGHT:—I think it will soon be found to be unwise to lay any gas mains smaller than 6-inch. A 2-inch wrought iron pipe is probably sufficient on cross streets if connected into a 6-inch main not over one block distant, but this is practically a service not a main.

F. H. SHELTON:—Yes, in every soil that is not absolutely bad for wrought iron. Wrought iron pipe will last a generation, if decently coated, and is far tighter than brittle cast iron in small sizes. A big company should never use 2-inch size. Lots of small companies will find it plenty large enough for many small runs, and it is unnecessary to "lay nothing else than a certain size." It all depends upon local circumstances.

E. J. SHERWOOD:—It is wise to use 2-inch wrought iron pipe for distributing mains. I have found that a 2-inch main will distribute gas as satisfactorily as a 4-inch main in residence districts if it is tied in properly every 1,200 feet with a feeder main. Two-inch wrought iron main has great advantages in regard to first cost and also in regard to leakage. Filled ground would cause 2-inch wrought iron main to deteriorate very rapidly, so wrought iron pipe should be laid only in good soil.

PAUL CHALLIS:—Yes, for short spurs where no extension will ever be made.

MASTIN SIMPSON:—It seems to me that it is a short-sighted policy to use 2-inch wrought iron pipe for mains. My experience, both in the country and city, has been one of considerable trouble with this class of main, and I certainly think it poor economy and short-sightedness to use it.

ALTON LIGHT & TRACTION CO.:—Our experience is that it is not advisable to use 2-inch pipes for mains, because of the size only.

J. H. ENRIGHT:—Yes; if soil is suitable, and main supply for district is ample, one can carry a few consumers on by-streets successfully. Otherwise I believe it a mistake to do so.

CLARENCE S. LOMAX:—I believe in the use of a 2-inch wrought iron pipe in clay soil where the limitations of a gas sale on that line are apparent from natural causes.

FRANK HELLEN:—Two-inch wrought iron pipe may be run for mains on side streets where the future consumption will never demand larger mains. I think it equally as unnecessary to run a 4-inch cast iron main on a short side-street as it would be to extend a 4-inch cast iron service into a terrace or appartment building. A 2-inch wrought iron pipe 300 feet long with a drop of four-tenths inch pressure will discharge 650 cubic feet of gas per hour. Just consider the number of families that 650 cubic feet per hour will supply, allowing 30 cubic feet maximum per hour for the average family.

B. F. BULLOCK:—Not unless using a high pressure system, or where there are only a few consumers to be supplied in a neighborhood not likely to be built up beyond the capacity of a 2-inch pipe.

W. E. BROWN:—Yes, particularly for residential lighting 2-inch wrought iron pipe can be quickly and cheaply laid down where the trade to be gotten would not pay for cast iron.

IRVIN BUTTERWORTH:—Yes, when well supplied with gas at one end if short, or both ends if long.

WALTON FORSTALL:—The use of 2-inch wrought iron pipe for a permanent main is advisable whenever it is very certain that the supply of gas to be needed in the future through the contemplated main will never exceed the capacity of a 2-inch. This means in practice, that 2-inch should never be laid except after careful consideration of the locality concerned, and a decision that the 2-inch will never be called on to supply many dwellings. Otherwise, and this has been observed quite recently, the unthinking use of 2-inch mains that after awhile complaints of poor supply come in, and pressure observations reveal lines of 2-inch that one extension after another have overloaded, so that they must be replaced by 6-inch or 4-inch pipe, making the final cost of mains larger by a good percentage than it would have been if so much 2-inch had not been laid.

There are occasions where a permanent main is not advisable, as for instance, streets not to grade, or runs through private property, and here within the limits of its capacity, 2-inch wrought iron pipe is admirably adapted for mains.

M. N. Latta:—The use of 2-inch wrought iron pipe depends somewhat upon environment and the quality of the soil. It is our custom here (Charlotte, N. C.), to use this pipe in sparsely settled localities, leaving "T" outlets "looking up" at regular intervals of from 50 to 75 feet. The soil here is especially favorable to the life of this pipe, we having relayed pipe after 30 years' service. The pipe was originally uncoated.

J. D. Shattuck:—It is wise to use a 2-inch wrought iron pipe for mains for short distances between large lateral mains; also, for high pressure work when mains be cut to 1¼-inch or smaller. All wrought iron pipe should be covered with cement or some other material to protect is against electrolysis.

E. M. Osbourne:—Sometimes, yes. Depends on what work it is supposed to do, and on the future outlook.

B. C. Cobb:—For high pressure lines, yes; for low pressure lines, no; except where there is no likelihood of future business demanding increased supply.

W. A. Baehr:—In regard to using 2-inch wrought iron pipe for mains, will say that where a block is of reasonable length, say 500 or 600 feet, and contains only two or three consumers and the prospects are that for four or five years to come there will be no additional consumption in that block and that there will be no paving done, the writer would say that the use of 2-inch mains would be justified.

In figuring up a distribution system for St. Louis, with the number of consumers that we encounter in a block in this city, we find that a 2-inch main will absolutely not carry the required amount of gas, even if perfectly clean, without a tremendous drop in pressure. The increased use of fuel appliances, which consume a great deal of gas per hour, is rendering our entire main systems too small and there are only two remedies open to us.

One remedy is to enlarge the mains. It now looks as though for the usual low pressure distribution systems for a city of the size of St. Louis, a 6-inch main is the minimum size that should be employed.

Another remedy is to work with higher pressure in distribution than has been the practice heretofore, placing governors on each service.

I would not hesitate to use a 2-inch main on a block 500 or 600 feet long where I saw nothing more than three or four consumers for possibly five years, but would try to secure connections to side main at both ends and would lay that main rather shallow with the expectation of replacing it at the end of five years with the proper size main.

W. A. **Aldrich**:—Two-inch pipe should never be used for mains; it is only a matter of time when it will have to be taken up. The writer advocates nothing smaller than 4-inch. A 2-inch pipe cannot be expected to supply satisfactorily more than 30 or 40 consumers, especially if they are using gas ranges in addition to lights. This does not refer to high pressure distribution.

John Wood:—For a low pressure system, a 3-inch cast iron pipe would be better in most cases.

F. W. **Stone**:—I do not believe it is advisable to use 2-inch pipes for gas mains. The cost of the 3-inch main is not greatly in excess of the 2-inch, and while 2-inch mains may supply all the gas necessary, if the main is of any length there is apt to be very uneven pressure at the further end. It is also hard to make a service connection to a 2-inch line. If you insert a tee, you are either obliged to run the service to the curb at the time of laying the main, or make a record of the place where the tee was inserted, which necessitates some extra work. If you do not insert the tees, and use saddles, the borings from the tapping machine are apt to drop into the main, making somewhat of an obstruction to the flow of gas. The only argument in favor of using the 2-inch line is the decreased expense, and it does not seem to me that this is justified.

J. **Wallace Shaeffer**:—Some good distribution men consider it advisable to run 2-inch wrought iron mains in sections sparsely populated. Whether the laying of such a main is advisable is determined by the estimated consumption of the few consumers. I have known cases where from 300 to 500 feet of such main have been run to reach a single consumer. In each case, however, the consumers agree to pay a portion of the expense, as determined by the company. The amount of this payment is figured from a consideration of the estimated consumption and the fixed charges and operating cost both.

Editor:—The writer has used a great deal of 2-inch pipe for distribution purposes and is sorry he has not used more. It is generally a safe rule in engineering that all excess material and excess weight is a weakening factor rather than a strengthening factor. This holds good in gas distribution work, as well as other branches of engineering. If a bridge were built with unecessary weight in any of its members, there is just that much unnecessary weight which must be carried by other members or by the foundation. The installation of a larger distributing main than necessary is apt to cause a much greater leakage, to say nothing about the unnecessary money employed. The best defense of inexact engineering planning is for an engineer to fall back on the old statement that he believes in building for the future, or that he wishes to be in accord with good practice. The wisdom of using nothing less than a 4-inch main, or later nothing less than a 6-inch main, cannot be mathematically demonstrated.

Two years ago my position on this matter seemed to be in discord with almost every other manager. I then took pains to more accurately determine certain fixing factors, only to have my former convictions strengthened. By numerous observations obtained by recording complaint meters, the maximum demands for many individual consumers were secured, and average demands for all consumers where these meters had been used were also computed. This was checked up with the maximum demand from the works. This data, originally collected from three gas plants and further contributed to from seven other gas plants, shows that the maximum instantaneous demand per consumer in any of these cities is 18.44 feet per hour and the average of all the cities is 14.9 feet per hour. The maximum average consumption per thousand feet of main is 363 feet, the average of all cities 308 feet. Of course I recognize that the consumption on certain one thousand-foot lengths is very much in excess of these average figures. But this means there are other lengths of one thousand feet which have a correspondingly less consumption. For all less than the average and up to the average it would be possible to supply great distances satisfactorily with a 2-inch pipe. Assuming that the 2-inch pipe is fed from either end and that gas is taken from it at frequent and equal intervals, the feeding distance would then be approximately one-quarter of the strength of the total length of the main between feeders. If we assume a consumption of 363 feet of gas per thousand feet, then the drop would be less than one-tenth of an inch of water per thousand feet of main. One thousand feet is seldom less than two blocks, and there must be very few blocks in any one city that cannot be supplied by 2-inch pipe fed by a feeder main if supplied from both ends of the block. The lesser investment required should each year be about ten times the recessive consumption. To just what extent

2-inch mains can be used would require a lengthy consideration of how the gas will be conducted from the works and the method of transmission and feeder mains used, together with considerations of pressure. But in the meantime I affirm that 2-inch mains can be used considerably more than at present to the advantage of gas companies, and that progress in gas distribution will be along the lines of maximum size for transmission and feeder mains and minimum size for distribution mains. Present methods of gas distribution, I think, are inexact, and frequently a profligacy is evidenced in distribution expenditures which is not justifiable.

It is needless to say that a 2-inch pipe cannot be made to carry gas unless properly laid and not congested with the insertion of service pipes. I have seen a 2-inch main tapped for a ¾-inch pipe extending into the 2-inch pipe to a depth of more than half an inch. To compensate for inexact planning, improper forethought and clumsy work on the part of the workman, 4-inch pipes will be desirable. With proper planning and proper work the bulk of all the gas mains of a gas company might be two inches in size and yield better pressure conditions than those which now generally pertain. Knowing how to use 2-inch pipe will also enable certain districts to be supplied profitably that are too widely scattered for larger sized pipes.

No. 103. What sort of a fitting or appliance should be used in tapping a 2-inch wrought iron main?

JOHN CASSIDY:—In regard to tapping a 2-inch wrought iron main, it all depends how large a tap is necessary. I hape tapped a 2-inch wrought iron pipe, with pressure on, with a Geo. Light tapping machine up to ¾-inch, which is the size hole we use for our services (the average of which is one inch). We use a combination tap and drill. It is necessary to be very careful so that the drill will not go through and through.

C. W. BENNETT:—I think the better plan is to cut a 2-inch wrought iron pipe, and insert a tee rather than tap it.

NEW YORK & RICHMOND GAS CO.:—We do not tap 2-inch mains, but cut out and put in a fitting, using a running thread. The thickness of metal in a 2-inch pipe is insufficient for proper threading, and the strength of the main pipe would be materially reduced if tapped.

PAUL CHALLIS:—A saddle. If 1½-inch or 2-inch branch is wanted, cut in a tee.

MASTIN SIMPSON:—The 2-inch main is too small to be tapped, for two reasons—enough threads cannot be secured to make a tight joint, and every tap over one-half inch (which is too small for service) only weakens the pipe to such an extent that it is of no value.

GEO. F. GOODNOW:—In tapping a 2-inch pressure wrought iron main, we use a single strap saddle fitted to the main with a round lead gasket which sets in a groove in the saddle. The saddle is tapped half-inch and a street tee screwed in, through which opening the main is drilled. By using a larger tap in the saddle and a larger drill to perforate the main, this arrangement will make an excellent fitting for a low pressure pipe of this size or a 3-inch or 4-inch wrought iron main.

ALTON LIGHT & TRACTION CO.:—It has been the practice of this company to use cast iron tees at intervals for the purpose of taking off services, and this was found very satisfactory.

F. C. WEBBER:—To tap a 2-inch wrought iron main, we use what we call an old crow, or dead man, a ratchet drill stock and a combination tap and reamer, or threader. After tapping a hole in the pipe for a 1-inch service, we put on a pipe clamp, tapped and threaded for a 1-inch pipe, and between the main and clamp we put a piece of rubber or leather around the main to insure the clamp making a tight joint.

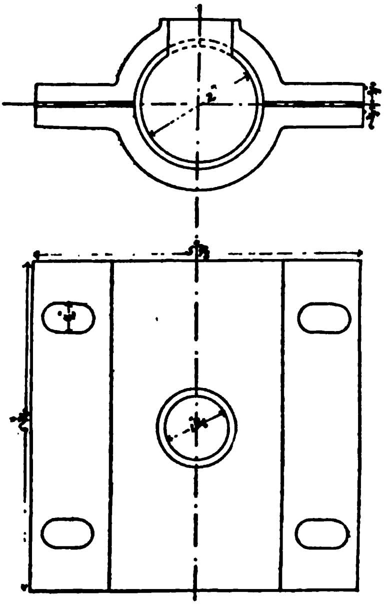
We do not make a practice of tapping a 2-inch main for a 1-inch service, but generally cut out from 18 inches to 24 inches of the main and put in a 2-inch running thread with a 2 x 1 inch tee on one end, and connect up the main with this piece of pipe.

PHILO JONES:—We have largely obviated the necessity of tapping 2-inch mains by putitng in crosses every 40 to 50 feet when laying the main. The original cost is not increased materially, and the saving in expense of tapping later makes the cost of the crosses a good investment.

G. W. FALLER:—A cast iron sleeve, cast in halves (see sketch), is bolted around main where connection is to be made, using 1-16 inch sheet lead as packing—lead cut nearly as long as circumference of main, and as wide as length of sleeve. One section of sleeve is cast with 1⅛-inch hole in center of face, and the sleeve is placed on main so as to bring this hole on top.

A 2-inch wrought iron main is always tapped for 1-inch pipe, using a Geo. Light or Mueller tapping machine, and the service connected to the main with a street T and street L. For a 1¼-inch service use a 1 x 1 x 1¼-inch street T and 1¼-inch street L.

By the use of a street T and street L, a positive drip of the service pipe is obtained without strains on the main due to sagging of the pipe or carelessness in tapping. Having a street T on the main facilitates the examination at this point for obstructions, etc., and needling.



Scale - ½ in. = 1

FIG. X.

B. F. Bullock:—Tap a ¾-inch hole and use a saddle strapped to the main, making sure to have a good white lead joint between main and saddle. Screw a 1 x ¾-inch street ell in saddle.

Frank Hellen:—Where 2-inch wrought iron pipe is run for main, I should provide for future services by leaving a fitting for each house or vacant lot. Where there are no fittings left for future services I should use Dresser tees, which can be readily placed and are not apt to leak.

W. E. Brown:—This depends upon the size of the main to be connected. If 1-inch or larger, the best way will be to cut the main and put a tee in; if ¾-inch or smaller, the main can be tapped in the usual way.

Irvin Butterworth:—A tapped malleable saddle, clamped on the main, as is successfully employed by the Denver Gas & Electric Company.

J. D. Shattuck:—The National Tube Co.'s service clamp with small lead ring gasket. These clamps will hold most any gas pressure and are used on high pressure natural gas mains as well as high pressure illuminating gas mains.

R. Shacklette:—A saddle should be used when it is necessary to tap a 2-inch wrought iron main. In laying small mains we make a practice of placing a tee at every point where there is a probability of a new connection.

E. M. Osbourne:—Too small to tap. We never use less than 1-inch pipe for service, and a 2-inch tapped for 1-inch pipe I think would be awkward. We cut them and insert cross or tee.

J. Wallace Schaeffer:—I have frequently tapped such 2-inch wrought iron mains as mentioned in this question by inserting in the line a 2 x 2 x 1½-inch tee, a nipple and a coupling.

F. W. Stone:—For services larger than 1¼-inch, put in Dresser tees, or some similar device for 1¼-inch service and smaller, use a saddle. You can tap directly into the main, but on account of the small circle of the 2-inch pipe, the screwing of the fitting into the main obstructs the flow of gas.

John Wood:—A 2-inch tee.

No. 104. Would it not be desirable for pressure regulators to be placed on each service if cost could be kept below $2.00 per service?

F. H. Shelton:—Yes, as there is nothing more desirable than a *uniform* pressure.

New York & Richmond Gas Company:—The correct answer to this question depends entirely upon the variation in street main pressure. If location and conditions are such as to make a considerable variation in pressure, yes; if a fairly even pressure is obtained from street, no.

Geo. F. Goodnow:—We are now delivering gas to regulators placed just before several hundred meters up to 30 lbs. pressure, and in our three years' experience we have never had an accident; the regulators reduce the pressure to approximately 30-10 with reliability and accuracy.

FRANK HELLEN:—I believe regulators are an improvement, but would not advise their general use, as it certainly means reduced consumption. Place them where you know the pressure exceeds 4 inches maximum and is so strong as to cause poor combustion in Welsbach lights and breakage in globes and mantles.

IRVIN BUTTERWORTH:—Yes, if perfectly reliable ones could be obtained that would not suffer much deterioration nor require much attention.

WALTON FORSTALL:—This question cannot be answered "Yes" or "No" as an abstract proposition. The sole idea of a service or house regulator is to insure the supply of gas under proper conditions of pressure. If such conditions do not exist at the head of such service; in other words, if the location of the works, or the size of the mains, either or both, is such that some or all of the consumers are subject to more than permissible variations of pressure through the twenty-four hours, then it is a question of relative economy in first cost and operating expense, whether the proper pressure regulation be attained through service regulators or through changes to the main system. It is easy to be seen that where services are very numerous per mile of a main, a charge of $2.00 per regular, will say 25 cents as an annual operating charge, would make the regulation of pressure by means of a better main system the more economical method. In this connection it may be interesting to note that in Philadelphia the great majority of consumers have at the head of services, pressures of twenty-five tenths, with a variation of perhaps five-tenths each way in the twenty-four hours.

M. N. LATTA:—The writer does not believe in the use of pressure regulators under any conditions where they can possibly be avoided, as they eventually are a source of trouble and annoyance.

No. 105. What rule should fix the depth to which gas pipes should be laid on differently paved streets and for different sized pipes?

J. J. KNIGHT:—The rule for fixing the depth at which gas mains are laid should be applicable to all sizes of pipe and all streets whether paved or not. As a rule, mains should be laid deeper than is the usual practice and not less than four feet to the top of the pipe.

The difference in cost between laying a gas pipe three feet or four feet is very slight, and the greater depth protects both mains and services from the high compression road rollers now becoming so popular in paving and other street work. Also protects from frosts and changing street grades.

F. H. SHELTON:—According to latitude and average winter thermometer, and deep enough in any case to avoid trouble from heavy cartage.

NEW YORK & RICHMOND GAS COMPANY:—Depends entirely upon climate and character of street traffic; anyway not less than 2 feet 6 inches cover.

MASTIN SIMPSON:—The depth to which pipe should be laid is governed in a general way by three provisions: The question of getting below the frost line, the matter of avoiding obstructions, and the question of securing sufficient pitch for drainage. It seems to me that with these thoughts in mind it is a question that has got to be determined from the location and each particular case. I neglected to say that in my own experience the question of the traffic on the streets cuts quite a figure, as both under a concrete pavement (which is frequently poorly laid) I have had small pipe break in numerous places with eighten inches of dirt and one foot of the best cement asphalt over the top; and I have also had four and six-inch main break and crumble under the steam roller when having two feet of cover with a good bed under it. It does not seem therefore that any rule can be laid down as to an established depth to which pipe must be laid.

FRANK HELLEN:—On account of obstructions beneath the surfaces of paved streets no general rule can be rigidly followed as regards the depth of mains and services. All should be laid below the frost line. Large feed mains should be laid deeper than the smaller mains, in order to allow the smaller mains to drip into the feed mains, thus minimizing the number of drips. Mains laid behind the curb must be laid deeper than if laid in the street, in order that the long services supplying the houses on the opposite side of the street may have sufficient fall to drip into the main.

B. F. BULLOCK:—Put pipes low enough to be below the frost line and to escape the jar caused by general traffic. I have always found thirty inches covering deep enough for all kinds of paving.

W. E. Brown:—Put as near the surface as possible, depending upon the traffic. Cities and municipalities are constantly adding to the surface and seldom cut away.

Walton Forstall:—The three reasons for laying gas pipe deeper than would be necessary to clear the paving stones are: First, opportunity to receive condensation from services; second, protection from mechanical injury; third, protection from severe changes of temperature. The first condition could probably be satisfied in most cases by a depth of two feet (from top of main to top of paving) and in latitudes south of Washington, in small towns where traffic is never apt to be heavy, such a depth might with propriety be taken as a standard, especially where pipes of the standard weight of the American Gas Light Association are used, and 4 inches is the smallest size.

In a town of larger size, however, experience has settled on a depth of three feet as necessary to satisfy the second condition, and this is probably the standard in United States practice, being exceeded only in the New England States and those on the northern frontier, where four feet or more is deemed necessary to satisfy the third condition.

There seems no good reason to vary the depth with the character of the street paving or the size of the pipe. It would probably be unwise to assume that because a certain street was to be given a concrete base, less cover would be needed over the gas pipes due to the protection of the concrete arch, for the concrete as actually laid might be very poor stuff. Also though a very large pipe would stand more strain than a small one, the consequences of its breaking would be so much more serious that it would not be wise to lay it at a depth less than the standard. As affecting the third condition, there is no data known to the writer to show whether maximum and minimum temperatures under ground are influenced to any great extent by the character of paving.

J. Wallace Shaeffer:—A record of observed depths of frost in the ground extending over several winters should prove an excellent means for fixing the depth to which gas mains should be laid. Mains should lie below frost line, especially where mains are laid in streets having very heavy traffic. I have observed that in winter most main leaks in mains of 4-inch and 6-inch pipe are to be found in streets where the heaviest teams pass.

JOHN WOOD:—Where water pipe is laid at four feet, a uniform depth of three feet covering on mains has been found most satisfactory.

No. 106. What should be the relative leakage for 2-inch wrought iron pipe and 4-inch cast iron pipe?

F. H. SHELTON:—As nothing is to something. A wrought iron pipe should be absolutely gas tight until it is corroded through from outside sources. A cast iron pipe will leak surely with lead joints, sooner or later.

W. E. BROWN:—Depends entirely on the soil. Filled-up streets will cause trouble and leakage by the subsoil settling. In good solid ground the leakage should not exceed 5 per cent.

IRVIN BUTTERWORTH:—There should be no leakage from a perfectly installed 2-inch wrought iron pipe.

WALTON FORSTALL:—I do not see how any answer can be given to this question. A 2-inch wrought iron pipe should be bottle-tight until it is perforated by corrosion or ruptures under strain, while a 4-inch cast iron main, laid with cement points will be bottle-tight until subjected to a strain long enough to cause a break in pipe or joint. What in actual practice is the difference in leakage between 2-inch wrought iron and 4-inch cast iron, is probably not known to any one, as to make a fair comparison, all leakage due to services must be eliminated and the two systems should be of about the same age. The question is probably asked by someone who is in doubt about the use of 2-inch wrought iron for mains in the place of 4-inch cast iron. If the soil is good, wrought iron will last long enough to save in interest on first cost, its renewal charge, unless there is expensive paving in question, but if there is any doubt about the soil or the quantity of gas needed through the main, choose 4-inch cast iron.

CLARENCE S. LOMAX:—The leakage of two-inch wrought iron pipe should be less than 1 per cent., while it is very difficult to get four-inch cast iron pipe to average less than 3 per cent.

J. D. SHATTUCK:—Four-inch cast iron pipe with cement joints can be made as tight as 2-inch wrought iron pipe. Laid under proper conditions, both are absolutely tight except in cases of breakage, when the leakage from the two sizes of pipe would be in proportion to their diameters.

JOHN WOOD:—If well laid, they will both be tight.

No. 107. Where both lead and cement joints are used on cast iron pipe, how often should a lead joint be put in?

F. W. BLOWERS:—All specials should be connected with lead joints, and every eighth joint on a straight run of main should be lead.

B. F. BULLOCK:—At least one in every five joints.

FRED H. BECK:—About every 200 feet.

CLARENCE S. LOMAX:—I believe in making one lead joint to two cement ones.

IRVIN BUTTERWORTH:—In Columbus, Ohio, the gas company followed the custom for years, with success and satisfaction, of making every fifth joint of lead.

WALTON FORSTALL:—This question will probably be answered in as many different ways as there are men who answer the question. Our experience with cement joints in Philadelphia began in 1900, and since that time we have laid over 100 miles of mains in all sizes, from 4-inch to 30-inch inclusive. Of this the sizes 12-inch and under were laid using lead joints at street intersections only, except a small amount which was laid with every eighth joint lead. In 1902, 5,500 feet of 16-inch, 4,500 feet of 20-inch and 4,000 feet of 30-inch, were laid with lead every eighth joint, except for one stretch of 3,400 feet of 20-inch, where lead was only used at intersections. A comparison of the distance apart of two marked points on either side of a lead joint in the 30-inch line, as between August and January, showed that the total movement could be accounted for by the contraction in only twenty-four feet of pipe, and therefore if a lead joint was needed at all, it ought to occur every second joint. However, as no leaks developed on the 20-inch laid with lead joints only at intersections, it was decided that lead could be dispensed with and in 1903, 8,000 feet of 30-inch, 1,200 feet of 20-inch and 2,900 feet of 16-inch was laid with all cement joints. Up to present writing not a leak has developed on this work and the leaks found on the small pipe have been few in number. Therefore our answer is that no lead joints need be used with cement.

JOHN WOOD:—Use all cement joints. I have seen no underground joints drawn nor pipes broken without other causes appearing than contraction.

E. E. EYSENBACH:—Use all lead or all cement joints. The reason for using cement joints with occasionally a lead joint is to provide for expansion and contraction, but in practice it does not provide for this. When mains are laid with 3½ to 4 feet of cover, there does not seem to be much variation in temperature, consequently not much expansion and contraction, and even if there was, the big bells present such obstacles to movement of pipe that the expansion would not be transmitted to the lead joint. I therefore advocate that in selecting joint, use all lead or all cement joints.

JOHN J. POWER:—I have put on a lead joint to every six of cement with fairly good results. But for best results I prefer all joints made of lead.

PAUL CHALLIS:—One in every six to ten, according to depth.

MASTIN SIMPSON:—This question interests me very much. I am one of the few who do not believe that it is necessary to put lead joints in cement runs. It is a common practice to use lead every fifth joint. In this city (Kansas City, Mo.), I have laid several runs of 1,500 feet and more, in fact, if my memory is correct, as high as 3,200 feet of 4-inch and 6-inch pipe without a single lead joint, and they have stood without leakage or breakage for six years. In other cities I have laid 8-inch, 10-inch and 20-inch in runs of from 1,000 to 3,000 feet without lead joints, and as far as I know, have had no trouble to date. I have talked this matter over with several theoriests and they refer me to the present method of making a "weld" of street railway joints, which is nothing more nor less than a bond, and the rails do not break nor buckle, although such solid connection may extend for several miles. This is against the old theory that the joints had to be free for contraction and expansion. The theory seems to be that the movement which causes the rails to crawl is taken up by molecular action where the rails are rigid.

JNO. H. FITZGERALD:—When I used both lead and cement for joints on cast iron pipe, I made one lead joint every seventh length, or three in a block exclusive of the crosses, which were also made of lead. This plan has been abandoned, and for the past two years no lead has been used except in very bad or "shifty" ground, where there is danger of settling. In such localities lead is used to reduce the risk of breakage. I do not believe the temperature between summer and winter in south Texas will have any appreciable effect on mains laid three or four feet underground. My experience with all cement joints has been satisfactory.

E. J. SHERWOOD:—A lead joint should be put in every 100 feet if the pipe is laid below the frost line. This practice seems to give us no trouble with leaks due to expansion and contraction.

B. C. COBB:—Each eight to ten joints.

J. WALLACE SHAEFFER:—I should say that one lead joint in fifteen would be sufficient. I have seen good results from all cement joints in 6-inch mains running for two or three blocks.

No. 108. What is the best cement to use for cement joints in cast iron pipe?

F. W. BLOWERS:—Alsen's Imported Portland cement seems to give best satisfaction.

J. J. KNIGHT:—We think that Alsen's German Portland is the best. It should be fresh.

W. W. LUNGREN:—Portland cement would be best to make joints on cast iron pipe.

FRANK HELLEN:—We find the German Alsen cement affords us most satisfactory results.

B. F. BULLOCK:—A good quick-setting Portland cement.

MASTIN SIMPSON:—I have experimented with twenty to twenty-five brands of cement on cement joints, and the best results have been secured from "Dykerhoff German Portland Cement." It has seemed to have been affected less by night and day temperatures of the pipe while the joints were setting.

JNO. H. FITZGERALD:—Any first-class, fairly quick-setting Portland cement. I have found Alsen, Atlas, Alpha and Vulcanite satisfactory. No sand is used.

J. H. ENRIGHT:—The best Portland cement.

IRVIN BUTTERWORTH:—At Columbus, Ohio, the gas company for years used ordinary Louisville cement with success and perfect satisfaction.

WALTON FORSTALL:—Prior to 1903 we used Dyckerhoff, but having some trouble in procuring it and there being some indication of its varying in quality, we made tests of several brands of American Portlands, and found little to choose between them, as they were all excellent. However, we finally decided on the Star brand.

J. D. SHATTUCK:—Mannheimer cement.

J. WALLACE SHAEFFER:—Some superior grade of German Portland cement.

JOHN WOOD:—A good Portland cement, and then have the joint finished before the *first* "set" of the cement.

F. W. STONE:—Any slow-setting Portland cement, which on test will show it does not expand or shrink too much in setting, will answer. We have found the Rosendale Portland cement very good.

B. C. COBB:—Genuine German Portland cement is considered preferable.

No. 109. What is the best method of locating leaks in house piping? What instructions should be given?

W. W. LUNGREN:—Upon entering the premises the first thing to do is to start with gas turned on from inlet side of meter, examine every exposed pipe and fitting in cellar, then go through house, examine fixtures and tighten all loose keys, put on mercury test and if leak still exists, put on ether test, which will enable the fitter to locate the leak in a few minutes.

B. COLES:—By using a pump and gauge and ether or peppermint, cap riser on all outlets and proceed in regular house testing method. Never allow a fitter to test for leak in concealed piping with gas pressure on, as accidents are liable to happen.

FRANK HELLEN:—Never search for a leak with a match or a light. Use the sense of smell; it is safer and more reliable for the following reasons:

1. Fire may cause explosion.

2. Flame may discolor any article it approaches.

3. Odor from flame may prevent later detection of a very small leak by the sense of smell.

4. A small leak when lighted burns with a blue flame which is almost invisible, yet may melt a solder joint or ignite other material.

5. A small quantity of gas mixed with air forms a dangerous explosive, hence fire in a leak near concealed piping or where gas has accumulated is particularly hazardous. Never permit fire or light in any form in an apartment where gas is escaping. A current of combustible gas mixed with air will drift some distance from its source and will, when lighted, fire back like a fuse to the main volume, causing explosion.

Always, before repairing or disconnecting any gas pipe or apparatus beyond service or meter cock, take the following precautions:

(a) Notify occupants of all premises supplied that gas will be temporarily shut off and that all burners in use, including pilot lights, should be at once closed.

(b) Shut off gas completely at cock or valve directly supplying pipe to be disconnected.

(c) When work is finished, notify occupants of all premises supplied that gas will be turned on and to assure themselves that all burners remain closed.

(d) Turn on gas at cock or valve which you closed before beginning work.

(e) To determine whether leak exists beyond meter, assure yourself that *all burners, including pilot lights,* supplied by meters, *are closed.* Turn on gas at meter cock. Watch small test on meter dial. If hand moves, leak exists. Locate and close leak. Continue thus until hand remains absolutely stationary during five full minutes.

(f) To locate a leak, use first the sense of smell, particularly at pipe joints and fittings. If still doubtful of leak,, apply carefully at each joint and fitting strong soap suds and watch for expanding bubbles indicating leak.

(g) If you cannot locate or cannot close the existing leak, shut off gas completely at the cock or valve directly supplying such leaking pipe or apparatus.

(h) Disconnect one of the side brackets and pour into pipe a small amount of ether. Connect air pump and raise pressure to five pounds. When fumes of ether will have spread through the whole system of house-piping, the location of the leak may be readily detected by the sense of smell.

B. F. Bullock:—If the pipe is concealed, remove all fixtures and cap up openings securely. Use a pump and mercury gauge. Put about one-half teaspoonful of sulph. ether in gauge and pump up. It is best to have two men testing; one at the gauge to keep the pressure up, the other to trace over the line of pipe to try to locate the smell of the ether. When found, test again with soap suds to locate it exactly. Mark leak and finish inspection. Repair leaks found, and try the gauge again. Oil of peppermint is a good substitute for sulph. ether.

W. E. Brown:—Use an air pump. Nothing else will discover small leaks.

M. N. Latta:—First, the introduction of essence of peppermint or wintergreen into the main risers under pressure from the air pump, to ascertain the general locality. This being learned, all piping should be painted with heavy soap suds and the leaks, as designated by bubbles, marked.

J. T. MASON:—Should a complaint of a gas leak in the piping of a private house come in, the man should be instructed to enter the house and inquire of the party or parties living there as to the location of the leak. In that way, he will be able to find in what part of the house the leak is, whether in the cellar or upper part. The man should have with him wrenches, torch, an Ever Ready Electric Safety Light, some plumber's cement, a tin cup, a small paint brush and a piece of soap.

Should the man be informed that the leak is in the cellar, he should take his safety light, go into the cellar and if the gas is any way strong open all the windows to air the cellar. At the same time he should go over all uncovered pipe from where the service comes through the wall, making sure that the gas does not come from the service outside the wall. Let him follow the piping along with his hand and nose, locating the leak by feeling the gas blow on his hand or by smelling. If this does not locate the leak and the gas is still strong in the cellar, he should make up a can of soap suds and go over the pipe with his suds and brush. If the leak is in the cellar, this will locate it. Should the cellar be large and free of any trash or much inflammable material, after airing the place well, it would be permissible to follow the pipe with a candle or torch, but at any time this is risky and should not be recommended. Should the leak be in the upper part of the house, find the room where the gas is strongest, try all pipe and fixtures in sight with the same methods spoken of above. If all fail and the man decides the leak is under the floor, or in the walls, it is a job for a plumber and not a gas-complaint man.

If the leak be found and it is one that cannot be fixed at once, let the man heat the pipe if possible and stop the leak with his plumber's cement. Should the gas be too strong to risk heating the pipe, stop the leak with soap and get the fitters at it as soon as possible.

The best way to locate a leak in the walls would be to shut off the gas at the service cock, disconnect at the meter, connect on the pressure pump with mercury pressure gauge, pour a small quantity of ether in the pipe and pump the pressure up to three to four inches mercury. The ether will soon make its presence known by its odor.

J. D. SHATTUCK:—To properly locate leaks in house-piping, the meter should be disconnected and the line capped, and a force pump put on some convenient bracket outlet. Ether should be pumped into the pipe and four to eight pounds pressure put on the system. Some person other than the one pouring ether into the pipe should then go over the pipe system until the leak is discovered. All fixture keys and swing joints should be greased and tightened before putting on pressure. The nose should be depended upon to locate all leaks, whether testing with air or gas.

G. I. VINCIENT:—The house-pipes may be in one of three conditions, either "meter in gas on," "meter in gas off," or "no meter in."

With "meters in gas off" the gas may be turned on temporarily in order to locate the leak. If no meter is in, ether or oil of peppermint should be introduced into the pipes by a force pump, and the leak located by the odor.

If the leak is a bad one, the gas need be only turned on for a few moments at a time. The place where the gas or ether smells strongest should be examined first. If coming from the floor, pry open the cracks in the floor, or drill small holes to try and locate as nearly as possible the exact point. If coming from the walls, make small nail holes in the plaster for the same purpose.

No large opening should be made either in floors or plaster until the leak has been definitely located. Access should always be gained to the piping where possible, by taking out floors, surbases, or wainscoting, in preference to cutting into the plaster, particularly if the latter is covered with wall paper.

In hunting for a leak where either gas or ether is used, the only artificial light should be a safety lamp. If in using gas to locate the leak, a quantity escapes into the room or rooms, these should be ventilated. If there is the slightest danger in using gas to locate the leak, such as open fires burning in the rooms, it is better to disconnect the meter at the outlet and use ether.

It is assumed in the above that the leak that is causing an odor is in the piping in the house from which the complaint was reported. This can always be determined by watching the test dial on the meter, or by shutting off the gas, and noting if the leak stops.

A leak found coming from neighboring premises should, of course, be located and stopped.

Another class of house-pipe leaks is that which does not annoy by the odor, but causes an increase in the consumer's bill. This condition is brought about by leaks in partitions where there is draught enough to carry the gas off, allowing none to escape to a point where the odor will be noticed. This leak would be shown by a movement of the test dial of the meter, and from the nature of it can only be located by isolating the house-piping into sections. The instructions necessary for men engaged in this work can be developed from the above discussion.

No. 110. What instructions should be given for finding cause of poor gas pressure when a whole district is affected?

H. H. Ganser:—After reaching district affected, go from door to door until you find where complaint begins, light all of the burners and go to houses nearest on each side and do the same thing and notice conditions of lights. I do not recommend the use a pressure gauge in running down an order of this character owing to the fact that an employe is often misled by the fact that if it is a resident section, he would have normal pressure registered even if it were only an opening in the main large enough to pass a lead-pencil. When I say, note the condition of the flame, I mean that by close observation you can tell whether it is water in a drip or whether it is a stoppage of another character.

Walter M. Blinks:—This is very fully answered on page 59 of Vol. 20, Proceedings of the American Gas Light Association.

W. W. Lungren:—If poor pressure is in house-pipes, fitter can light all burners, which will enable him to locate the difficulty without much trouble. If poor pressure is in main, it will be necessary to make a house-to-house canvas with gauge until the trouble has been found.

B. Coles:—First get an opening as near main as possible, and if service and main are clear then examine meter, and if no obstruction is found proceed along riser and so on until trouble is located.

J. H. Enright:—This question was well answered in last year's proceedings. Any all-round gas man will not lose much sleep over troubles of this kind.

Irvin Butterworth:—In a general way, use the "U" gauge in accordance with the instructions issued by the Denver Gas & Electric Company to its employes (see *Progressive Age* of February 15th, 1902, page 74), and make special investigation of local conditions at the point where the gauge indicates the greatest drop in pressure.

M. N. LATTA:—A series of tests should be made throughout the locality and the drop between testing points carefully noted. These tests should be made, if possible, during the period of greatest demand. Calculations of the natural drop, due to friction between these points, should be made. Any marked discrepancy would denote some stoppage, partial closure of valves, unpumped drip, flooding of main, etc. In testing for poor pressure in house-piping, a similar test should be made, commencing with the service side of the meter and testing throughout the house in sections, all burners being preferably lighted.

J. T. MASON:—Should the poor pressure cover a district it may mean the drip in the district needs pumping. If that does not clear away the trouble, then it is a case of the main being blocked, or maybe it is too small. In case of a blocked main, the trouble will have to be located with pressure gauges, starting from the point where the pressure shows normal and following the main with another gauge till the drop in pressure is found. Then a hole must be tapped in the main and the nature of the stoppage ascertained. If it is naphthalene, pour some naphtha in the main and pump it out of the nearest drip. If it is frost, pour in alcohol. If it is dirt that cannot be blown away or rodded so as to let the gas flow with sufficient pressure, then the main will have to be cut each side of the stoppage and renewed, or cleared and replaced.

PAUL CHALLIS:—Examine drips. Take pressure to locate point of drop.

F. W. STONE:—See if the trouble is caused by the defective fixtures, or if it is really a case of low pressure. If low pressure, see if it is general in that locality, or confined to that one service; if general, at what time the trouble is the worst. If local, find whether it is between the main and meter, or between meter and fixtures. After that, use what means circumstances may indicate as best, localize the trouble, and report fully to the office.

NO. 111. At how high a pressure is it safe and practical to deliver gas to consumers' meters?

F. H. SHELTON:—Ask a meter maker. I understand that meters are tested to two pounds, and personally, would not care to operate on more than one pound, and would then watch pretty carefully the accuracy of registration. This applies to tin meters at ordinary low pressure, and even in high pressure work it also applies, because a regulator cuts the gas down to low pressure.

A. F. **Reitemeyer**:—Twenty-tenths at least. Gas companies carrying less in order to decrease leakage make a grave mistake. The increase in consumption would more than offset the leakage in carrying a higher pressure, and prevent consumers from complaining continually.

Fred H. **Beck**:—As high as four inches of water pressure.

Irvin Butterworth:—If the pressure were reasonably steady and constant, I believe that ordinary meters would safely withstand a pressure of one pound.

F. W. **Stone**:—The answer to this question seems to depend on the kind of gas you are selling, and the purpose for which sold. With natural gas, the average pressure at which it is delivered to the consumers' meters is from four to eight ounces, which is from two to four times as much as the average highest pressure at which artificial gas is delivered. I have seen a tin meter registering gas under from 12 to 16 ounces pressure, without apparently any injury to the meter and with good results to consumer.

Wm. McDonald:—If the two-diaphragm tin meter is meant, it is my judgment that five pounds to the inch can be used if the speed at which the meter is run is carefully controlled.

No. 112. What is the maximum amount of gas a meter of each size up to a 30-light will pass a month, without undue injury to the meter?

M. N. **Latta**:—Consumers' meters are supposed to have three times their "rated" capacity at six feet consumption per burner hour, or a five-light meter would have a capacity of 5 × 3 = 15 × 6 = 90 cubic feet per hour. In the same manner a ten-light meter should have a capacity of 180 cubic feet per hour.

Wm. McDonald:—If the meter is run twenty-four hours per day for thirty days, say 30,000 for three lights, 50,000 for five lights, 80,000 for ten lights, 120,000 for twenty lights, and 160,000 for thirty lights.

A. H. **Strecker**:—This question is rather too indefinite to be answered with any degree of accuracy. It asks what the maximum quantity of gas is which a meter of given size will pass *per month,* without straining itself. Now, the amount of gas a meter will pass in an hour with a given loss of pressure is something definite; but as to the monthly performance, this depends altogether on the number of hours a meter is in use. If it were to supply, for instance, an engine or appliance running steadily for ten or twelve hours every day, the showing per month would be very high compared with another meter of the same class, furnishing gas at the same rate, which would be in use only one hour per day, although the speed of the meter and the strain upon its works would be the same in either case.

At a loss of pressure of 2½ tenths, running at an easy speed, at which no flicker in the lights supplied is perceptible, the various sizes of square meters inquired about will deliver approximately as follows:

3 light meter	30 cubic feet per hour.
5 light meter	50 cubic feet per hour.
10 light meter	80 cubic feet per hour.
20 light meter	140 cubic feet per hour.
30 light meter	200 cubic feet per hour.

Make and condition of the meter, as well as specific gravity of the gas, will of course influence these figures. Round, three-diaphragm meters deliver more gas under same pressure than square, two-diaphragm ones.

No. 113. If a new meter is used to its fullest capacity, what is its average life before requiring repairing?

Frank Hellen:—No meter should be used to its fullest capacity constantly, for if this occurs the drop in pressure between inlet and outlet will increase to inches, causing fluctuation and consequent dissatisfaction to the consumer. The average life of a meter located in a dry, warm atmosphere, with a maximum difference of five-tenths inch between inlet and outlet connections, is about five years, without repairs.

Mastin Simpson:—The common practice is to take the meter in at the end of two years, and from the large percentage requiring repairs under my experience it seems to me that two years would be about right.

Wm. McDonald:—Not to exceed thirty days.

A. H. Strecker:—An answer to this question can only be a qualified one. The inquiry is as to the life of a new meter when used to its fullest capacity. Now, if by life is meant the period during which a meter has been in service before being brought to the repair shop, it may be a very short one. So much depends upon the condition of the gas. This may be such that after a short time of service the valves of the metre become dirty, causing flickering of lights and removal of the meter for cleaning; and yet these repairs are but slight ones and the meter is good in every other respect.

Of a large number of meters (many thousands of them both new and old at the time they were set and which were brought in for examination after three years' service), 84 per cent. were found in good condition and registering correctly within the legal limit. Of those that had to be repaired, 9.6 per cent. (of the total number brought in) needed general overhauling, including new diaphragms. Of a lot of meters, new or as good as new at the time of being set, 4.3 per cent. only needed general repairs after three years' service.

On the basis of these observations, it would seem a conservative estimate to make the average period of active service of a meter, before needing general overhauling, at least five years. A five-light meter may thus easily pass 250,000 cubic feet of gas until it needs attention.

As to the absolute life of a meter, it may be said that there are in service to-day meters bearing the label of firms like Down, Code, Hopper & Co., etc., who went out of business all of forty years ago.

No. 114. What pressure will a two-diaphragm meter stand?

F. Langwith:—The question is rather vague. If the meter is at rest it will stand any pressure that the metal casting and seams will stand; again, there are meters that are working under a pressure of 18 inches; yet a meter should not be subjected to a pressure of more than 5 inches to give satisfaction.

Frank Hellen:—This question is not stated concisely. A 5-foot tin meter case will stand a pressure of three pounds per square inch. Where the drop in pressure between inlet and outlet of meter does not exceed five-tenths inch (and it ought never to be more than that), a diaphragm will stand an increased pressure of several pounds because the pressure is equally distributed on both sides of the diaphragm (less about three-tenths inch) without undue injury until such pressure is so great as to cause the leather to become porous. With a pressure of seven inches on inside of diaphragm (no pressure on outside) many diaphragms will leak. I have known new diaphragms to leak at five inches pressure, but this is exceptional, and I am sure that in no case will meters be used under this condition.

Wm. McDonald:—Ten pounds to the inch.

No. 115. Is it advisable to connect a meter in an exposed place in winter (for instance, under a porch) in southern climates, the meter being in a chilled condition 18 out of the 24 hours?

J. J. Knight:—It seems to me it would be unwise to do so, for, as I understand it, five degrees change in temperature makes 1 per cent. difference in the volume of gas.

B. F. Bullock:—By all means, no; if for no other reason than that the case will soon rust out.

Frank Hellen:—It is not advisable to connect meters in exposed places even though the gas does not freeze. Low temperature will cause gas to condense, which in turn will cause valves to become "gummed," shortening the life of the diaphragm and causing the meter case to become rusted. If a meter sets in a temperature of from 50 to 70 degrees, the life of the meter will frequently be twice as long as that of a meter set in a cool, changeable temperature.

Clarence S. Lomax:—I do not believe in exposing gas or gas appartus of any kind to changes of the temperature or weather any more than possible, and do not believe that it pays to expose a meter to weather.

Irvin Butterworth:—No.

M. N. Latta:—All meters should undoubtedly be placed in a protected locality where there is the least possible change of temperature. We suffer greatly here in the South (Charlotte, N. C.) from the abuse of this rule, the great changes in temperature (they being of more constant occurrence, even than at the North) causing the meters to "sweat" and fill with frost and condensation.

H. L. Rice:—Never if it can be avoided. Experience in Norfolk shows undoubted bad effect on leakage account.

G. I. Vincient:—It is not advisable to set a meter under those conditions for three reasons:

First—Experience has shown that where a meter is set in a place subject to all the changes of temperature that occur during the day, it is much more likely to fill with condensation than one set in an equable temperature. This is particularly the case in the fall when the atmosphere cools suddenly and earth is in practically the same temperature as in summer. The gas flowing through the mains and services is thus kept at a higher temperature than that of the meter and the latter simply acts as a condenser.

Second—A temperature but little below the freezing point will cause the side pipes and passages of a meter to stop with frost.

Third—A meter in an exposed place could scarcely be left in if the house were unoccupied, hence, it would be necessary to remove the meter every time a change of consumer took place, which is an unncessary expense.

No. 116. Is cement an absolute protection against electrolysis, and if so, what thickness is required to protect the pipe?

J. M. Humiston:—It is presumed that by the word "cement" is meant a concrete of one of the better brands of Portland cement. Such an envelope is not an absolute protection against electrolysis. Its efficiency would depend on the proportion of cement employed, the intimacy of the mixture and the amount of moisture in the soil in which the pipe thus protected was laid.

With a concrete one inch thick of one part high grade cement, two parts of sand and three parts of one-half-inch stone mixed and laid carefully, I do not believe an efficiency above 60 per cent. could be secured.

By this I mean, that a pipe so protected and subjected to the same influences as a bare pipe would last two and one-half times as long as the bare pipe.

Such construction for a four-inch wrought iron pipe would cost $11.70 per 100 feet; assuming that cement, sand and stone cost respectively $2.25 per barrel, and $1.60 and $1.50 per yard, and that the common hemlock lumber for a one-inch pine box cost $17.00 per M. It would be necessary to use the box, as without it the mixture could not be tamped with sufficient firmness about the pipe.

The only instance where I know of such construction being employed was one in which the Pintsch Compressing Co. laid a one-inch extra heavy pipe under the South Side Elevated Railway in Chicago, from 44th Street to 40th Street, a distance of about one-half a mile; the Elevated Railway at 40th Street, the nearest point, being about 1,500 feet from the power station.

The pipe was laid substantially as specified above, and was finished in November several years ago. The following October, when the gas was turned on, the line being out of service during the summer months, the pipe failed to hold the pressure, which was 150 pounds.

Mr. C. H. Peterson, who supervised the work and observed the results, told me that they were obliged to take up one-half a mile of pipe, which was almost totally destroyed.

Clarence S. Lomax:—In order to be a perfect protection against electrolysis, the cement must be free from cracks; the thickness, therefore, will vary with the size of the pipe and manner of laying the same.

Mastin Simpson:—I doubt if this question can be answered as it should be. I have never yet found men who would either coat with rubber pipe coating or with cement and pipe sufficiently well to determine the question in hand. Furthermore, a little rust, a little oil, an unclean spot on the pipe will destroy the entire value of the cement or coating. Furthermore, the use of the tools leaves the pipe in condition so that it is readily attacked at the weak points, and the expense of the coating has been thrown away.

Jno. H. Fitzgerald:—I am not qualified to say that cement is an absolute protection, but I am convinced that it is a very great protection.

J. D. Shattuck:—I believe one-quarter-inch thickness of cement to be an absolute protection against electrolysis.

Jacob D. Von Maur:—Would say that if a pipe is covered with cement one-half inch, or even less, in thickness, it would be proof against electrolysis and corrosion, but on account of the liability of the cement to break away from the pipe or crack, I believe it best to first surround the pipe with a box, then fill around the pipe with cement.

No. 117. How can pipe be coated with cement cheaply?

Jno. H. Fitzgerald:—Take two boards 1″×4″ and nail them together in a V-shape. This makes a V-shaped trough for the service-pipe, which should be kept about three-quarters of an inch from the side of the trough until the filling has time to set. Any good, merchantable hydraulic cement will make good filling. This is intended for service pipes only.

WALTON FORSTALL:—There is on the market a preparation of cement called Tockolith, manufactured by Toch Bros., 468 West Broadway, New York City, which with some care may be applied by a brush so as to form a very uniform covering. Of course it will crack off with rough handling, but it may be covered by a coat of tar or other paint and in this way protected until laid in the ground. We are now laying a few services coated in this way and after five or ten years may have something to tell.

J. M. HUMISTON:—The method described in the answer to question No. 116 is not a cheap method.

The practice of painting iron surfaces with a wash of Portland cement and water has found some advocates. Not all cements are adapted to this method, as the presence of certain chemical constituents and the absence of others is necessary to make such a coating effective.

Such a coating with two or more layers could be employed at a moderate outlay, but I am not aware that it has ever been tried.

JACOB D. VON MAUR:—There are a great many things to be taken into consideration in answering this question. For instance, in St. Louis, we bore through the clay from the cellar to the curb. Now, in order to protect the pipe against electrolysis, it would be necessary to excavate the entire distance from the main to the cellar, so that in figuring the cost it would be necessary to add the difference between boring the service and excavating a trench in which to lay it. Fifteen cents per foot would be about right, if the service is to be covered in the manner described. On account of the excessive cost, I believe it to be best to only cover such services as from previous experience you have good reason to believe are short-lived on account of electrolysis or corrosion.

No. 118. Is there any other substance equally as good as cement for pipe coating and proof against electrolysis?

J. M. HUMISTON:—Any chemically inert substance which is substantially a non-conductor of electricity, when applied to the pipe in such a manner as to absolutely insulate moisture from the metallic surface, would be more efficient than a Portland cement concrete.

One fairly effective method of doing this is to surround the pipe with a coating of tar concrete, the tar and the gravel, sand or stone to be thoroughly dried and perfectly applied hot, the pipe to be laid in a wooden trough containing the mixture.

ROBERT WATT:—A coating of about one-thirty-second inch thick of either California, Trinidad, Gilsonite or Bermudez asphaltum, combined with petroleum residuum and sulphur, prepared in the following manner: The petroleum residuum is to be heated to 300 degrees F., 3 per cent. of common sulphur added to it, the same to be cooked to 300 degrees F. until the sulphur is thoroughly incorporated with it; then sufficient of this mixture to be added to the melted asphaltum until the asphaltum is of such consistency that it will not become too soft or run at 120 degrees F. or crack when struck with a hammer at a freezing temperature. The pipes should be dipped in this composition at a temperature of about 225 degrees F. In being laid, if the composition should in any way be removed or damaged, sufficient should be put on with a brush, hot, after the pipes are connected. This composition makes a perfect insulation and proof against electrolysis.

W. A. BAEHR:—Pitch is probably a better pipe covering than cement, and the experience with pitch seems to be very favorable in several cities, notably Grand Rapids and Milwaukee. It has been used in these two cities mostly on services.

A St. Louis firm has recently marketed a substance called "Perannite," which consists largely of sand and sulphur. This substance has a high electric resistance and at first we thought it would make a good pipe covering; later experience with it has determined that the substance as put on the market is too brittle. The slightest tap on it with any hard substance is apt to break the perannite off the entire length of pipe into small pieces.

The Laclede Gas Light Co. is about to install a Pintsch distribution system of some 40 or 50 miles of steel pipe, and a portion of this will be laid in plain concrete and another portion in pitch. The result of that construction will be very interesting from the standpoint of pipe covering, as there are usually heavy electric return currents in our piping and we have exceedingly difficult conditions to meet as concerns character of ground. We will distribute Pintsch gas at a pressure of from 200 to 250 pounds per square inch.

W. A. ALDRICH:—Boiled tar is as good as cement for protective purposes at very much less cost. Make a trough a little larger than the size of the pipe to be laid; boil the tar to a consistency nearly of pitch; fill the trough with the mixture. It is an absolute preventive of electrolysis.

JACOB D. VON MAUR:—Would say that we have used pitch and a new substance called "Perannite," which is manufactured in St. Louis. I believe that a pipe laid in a V-shaped wooden trough and surrounded with pitch is well protected both from electrolysis and corrosion. The objections are, of course, the first cost, and in our case, the necessity of excavating in order to apply the pitch. Regarding "Perannite," I can only say at this time we have installed a large number of services covered with this material, but as none of these services are over eight months old, it is too early to arrive at a definite conclusion as to its worth as a protective covering. Our main objection is that it is rather too brittle to stand ordinary rough usage. We will know better next year what we think of this material.

No. 119. What are proper instructions to give regarding investigating complaints of poor pressure?

H. H. GANSER:—The method pursued by our men is first to find out whether gas is coming from service at normal pressure by disconnecting inlet side of meter. If the trouble is not there, reconnect inlet side of meter and disconnect outlet side and ascertain if gas will pass meter as it should. If not there, then give attention to the house riser by trying first set of burners going therefrom. We have found that this method saves time, and very often prevents our going back a second time in the near future on the same order of complaint.

W. C. HUGHEY:—There are several complaints which come under the head of poor pressure. Often a trouble man is given an order of poor pressure, when possibly there is a stoppage at fixture, or a burner of the gas range needs cleaning. Now this man should be instructed in this manner: To attend to all complaints of a reasonable character and not say that he was just sent to investigate poor pressure or that he did not have an order to adjust range, tighten fixture, replace tips or clean tips. Trouble men should have an abundant supply of pillars and tips and inquire of the consumer if any are needed, and if so replace them. Such little acts of courtesy would lessen to a great extent the troubles of the man at the complaint window and leave the consumer with a good impression of the company.

But if complaints are not of the above nature, remove drencher fitting at service and see if service is clear. If service is clear, disconnect distributing side of meter and if not there, and trouble is found to be in rise pipe, notify consumer what is necessary to be done. Consumer should get his plumber and have cause removed.

FRANK HELLEN:—In the investigation of complaints of poor pressure the best qualified inspectors should be employed.

First—If pressure is found poor in all fixtures and appliances, the inspector knows that the trouble must exist in the service, meter or riser, and at once removes the plug from T on the end of the service. If trouble is located in the service, same should be promptly repaired and no further investigation is required.

Second—If trouble is not located in the service, disconnect outlet of the meter, and if trouble is found to exist in the meter, remove it and install another in its place, unless it is caused by water in the meter, which can be emptied and meter replaced.

Third—If the trouble is not located in either service or meter, it is usually found in the riser, and if not caused by freezing, is generally due to an accumulation of rust in one of the elbows, which can be readily removed by the use of wire and force pump.

Fourth—If supply is poor in one fixture and good in others, the trouble is not due to poor pressure, but is caused by stoppage in the fixture, which can be easily removed.

Fifth—If poor supply is in Welsbach lights only, it is usually caused by poor combustion, *i. e.,* improper amount of either air or gas, and burners should be adjusted during the period of greatest consumption.

Sixth—Poor supply to gas appliances is usually caused by poor combustion due to improper size of gas orifice, which may be either too small or too large, or to accumulation of dirt and dust in the air chamber.

IRVIN BUTTERWORTH:—See instructions for using the "U" gauge, in *Progressive Age,* of February 15th, 1902, page 74.

WALTON FORSTALL:—Assuming that the reference is to poor pressure within a house, a complete answer will be found on page 35 of Volume 18, Proceedings of American Gas Light Association, being one of the Practical Class answers.

J. T. MASON:—The question does not state whether it means poor pressure in a district or house.

Assuming that it means house pressure and that the man going to attend to the complaint is new at the business, he should be instructed to enter the house and inquire of the inmates as to whether the poor pressure is all over the house or in what part or room it is. If it is in one room he should examine the fixture and see that all is clear. The chance will be that by taking out the core of the burner cock the trouble will be found there. If by lighting several burners over the house, all show poor pressure, the man must look for trouble in the basement. Take off the cap at the service to see if the pressure is all right at that point. Should the pressure be bad, put on air pump and blow out the service.

Should the pressure be strong enough at the service, disconnect the outlet side of meter to see if the gas reaches that point with good pressure. If so, shut off the gas at meter and then take off cap or plug at the foot of the riser. If the man will hammer the pipe with his wrench a trifle, it will bring down any dust or dirt that may be in the pipe. If an opening can be made by taking off a wall bracket or cap upstairs, blow down through the pipe. This will, if the stoppage is not too bad, clear the pipe. After this is done, connect up the gas and try the pressure upstairs. If the pressure now shows good, the man should go over the house, light all the burners and make sure all the air is out of the pipes before leaving.

Should the above method fail, he will have to put on the air pump upstairs, open the pipe in basement and force it out. Afterward, make sure all the air is out of the pipe; otherwise as soon as the people go to light up in the evening a complaint will come in from the same house that "the gas won't burn," and that will mean another trip for someone.

J. D. SHATTUCK:—To make a thorough examination of poor gas pressure, the local main pressure at hour of trouble should at first be obtained through some convenient drip or lamp post. When this pressure is known, it should be verified at the head of the service with two or three lights burning on the house system. If the service is of ample size and clear, there will be practically no difference between the main pressure and the service pressure. The pressure should then be taken on the first convenient outlet beyond the meter and if still no loss of pressure is shown, the sizes of pipe should be examined throughout the house, number of outlets counted, number of fuel appliances, and the consumption of each. Seventy-five per cent. of the total possible consumption per hour divided by six should give the proper size of the meter. Each house line should be run out according to the table of the Gas Association standard. If the trouble is still not discovered, it must be in the particular fixture on which the complaint issued, and can be discovered by cleaning the fixture and the burners. Stopped pipes can be discovered by blowing through each individual outlet beginning at the top outlet and working down. If the pipes were made tight originally through the use of salammoniac, the blowing out with force pump will drive the rust or sediment to the elbows and completely shut off the system.

No. 120. What is the minimum grade permissible in mains and services?

HENRY I. LEA:—For low pressure work, about three-eighth-inch per length of pipe.

FRANK HELLEN:—I believe the minimum grade permissible in mains and services should be one (1) inch to every one hundred feet. I do not believe a grader can lay pipe satisfactorily with less grade than one inch per one hundred feet without the use of blocking, which is not advisable on account of the ultimate settling of the pipe in the trench.

J. D. SHATTUCK:—I do not think mains should have a grade of less than one-fourth inch for twelve feet length and that services should have at least an inch fall per length.

No. 121. Are iron meter connections preferable to lead, and if so, why?

JOHN CASSIDY:—For my particular use I would prefer iron meter connections, for the simple reason they are safer and stronger, holding the meter in better position. But they have their objections. The first is that a better class of fitters is required than gas companies generally hire, for it is quite a nice piece of work to get the connections perfectly true, which is absolutely necessary in connecting a gas meter. The second is that some meters vary a little in width, and if a meter has to be removed and another set and the latter is not exactly the same size, it means quite a little trouble and inconvenience whereas if lead connections were used, these could be bent to the required width. As far as cost, etc., is concerned, I do not think there is a great deal of difference.

S. E. MULHOLLAND:—The experience of several associated companies, having in use approximately fifty thousand meters in natural and artificial gas plants, has been that both iron and lead conections have their advantages as well as disadvantages, and that practically all of the advantages are secured by one iron and one lead connection, the rule being to have the inlet connection the iron or solid one, and the outlet, lead. This makes it possible to set and reset meters quickly, the iron connection giving the rigidity necessary, while the lead connection removes the strain that would be put on the meter where the two iron connections are not of exact length and distance apart; the result achieved being the advantages of both connections at less cost.

A. F. REITEMEYER:—Prefer lead to iron for three, five and ten-light meters. Above ten-light, iron by all means.

R. B. BROWN:—Iron meter connections are preferable to lead; are no more expensive; are safer; when once set they are free from leaks, nor can the gas be throttled by careless bending as with the lead tubes. The connections need not be removed when the meter is taken out, as the temptation to steal them is much less than with the old style. The connections being in place and in absolute alignment ready for the setting of the next meter, enable a meter setter to reset a meter in, at most, half the time required with lead connections.

With our type of iron pipe meter connection a five-light can be replaced with a ten by simply reducing coupling, and replacing it with a straight coupling with a ten-light swivel, which latter the wagon men always carry with them. As this change has to be made on account of increasing consumption quite frequently, this becomes a great convenience.

H. B. HARROP:—Reference: Wrinkle No. 3, Papers of Wisconsin Gas Association, 1903.

B. F. BULLOCK:—In my estimation they are not.

W. E. BROWN:—No. Lead is much the best.

IRVIN BUTTERWORTH:—Yes, chiefly because they do not kink or flatten, and thus constrict the passageway for the flow of gas.

WALTON FORSTALL:—See Proceedings American Gas Light Association, Volume 19, pages 314 and 315.

H. L. RICE:—Yes. In most cases they are cheaper and safer. Meter shelves can be done away with. One side iron and one side lead works well in some cases. Best rule is to use iron as much as possible, but to realize that lead in some cases is more suitable.

J. D. SHATTUCK:—Iron meter connections are preferable to lead because they cost less, are not liable to kink, give the full bore and are not stolen from vacant houses to be sold as junk.

F. F. Barnard:—In answering question No. 121, I would say, yes, for several reasons.

First—When meter is hung it is as stationary as the pipe.

Second—There is no chance of tipping and throwing it out of plumb.

Third—The lead connections soon dry out and become crystalized, thus causing leaks.

Fourth—The iron pipe will not kink, will allow the free flow of gas at all times, and makes a better looking job.

Mastin Simpson:—I believe the best plan is to make the inlet connection which carries the cock of iron and the outlet connection of lead. A man can connect a meter up more quickly under these conditions. It requires less time in the original fitting, places less strain on the meter itself, and will provide for the little variations which take place in the different makes of meters.

No. 122. Has any member had unfavorable experience with the Hickenlooper coating for services (See *A. G. L. J.*, Vol. 65, page 886), and if so, what are the details of such experience, and if other kind of coating is being used, give details of experience with it. Where Hickenlooper coating is being used, how old is the oldest service so coated and still in existence?

George W. Beck:—Three years ago we laid a mile of three-inch wrought main, coating it with a coal tar preparation made in Cincinnati. About 25 per cent. of this pipe was laid in low ground, where the soil is continually wet. Last summer we replaced this main with a six-inch cast pipe, and where the wrought iron pipe ran through the wet soil we could find no sign of the tar coating that had been put on but two years previous. The pipe showed a rusty surface throughout. Where the pipe lay in dry soil the coating was in fair condition, although not as good as I expected it to be. The pipe had been coated and allowed to dry thoroughly before being placed in the ground.

No. 123. Is portable testing of meters desirable?

Everitt House:—This question means this to us: Is it desirable to test gas meters generally on the consumer's premises, using portable proving apparatus? We believe it is desirable, and for the following reasons:

First—It would dissipate forever a too prevalent notion that a gas meter is an ingenious machine with an unjust discrimination between the consumer and the company's till, by affording a scientific but simple demonstration of the accuracy of the measurement at the home of the consumer.

Second—It would tend to encourage routine testing, thereby making very timely discovery of sluggish or broken-down meters, keeping the scales at a maximum and making it necessary to issue but a minimum of averaged bills. Along with this routine testing thus encouraged, there might be instituted a very general practice of making either rebates or additional charges for meters found fast or slow from time to time—a source of great satisfaction were conditions good enough to warrant it.

Third—Portable testing would avoid delays and some errors in records of changes, for in most cases the meters could be re-set immediately after proving. This would lessen the expense of the tests.

Fourth—It would advertise the company very generally if uniquely carried out. Something like an auto-truck with glass enclosures, having a full equipment of testing apparatus and appliances for keeping normal temperatures, if manned by a competent meter specialist, ought to make quite an imposing sign along the curb, thus doing double service. But in whatever form, it would advertise. The details of the equipment once solved and a trial given, we believe the office would answer the question affirmatively.

B. F. BULLOCK:—Only in such places where the testing of the meter has been neglected and it is desired to repair the worst ones first; otherwise it is better to test with a prover.

FRANK HELLEN:—I do not approve of the portable testing of meters for the following reasons:

First—It is not accurate, as it is impossible to secure as satisfactory results as may be secured with meter prover where the water in the prover, the air in the room and the meter itself are subject to the same temperatures.

Second—It causes dissatisfaction with consumers, many believing, in spite of all assurances to the contrary, that the amount of gas used in testing the meter will increase the amount of their bills, for it usually requires 20 minutes to make a test.

Third—It causes additional expense by reason of the fact that in many cases where gas is in use you find it necessary to make the second or third call before the meter can be tested.

Fourth—Every meter registering incorrectly will have to be brought to the shop. Taking everything into consideration, I believe meters can be exchanged and tested with the prover in the shop just as cheaply as by the hand prover and with double the satisfaction to the consumer and to the company.

M. N. LATTA:—This plan is not desirable, it being less active and liable to greater error.

F. W. STONE:—Portable testing of meters seems to be desirable where complaint is made by consumer that his meter does not register correctly. In this case the test meter can be taken to the place and coupled directly to the meter in use, and the consumer can be present and see the meter tested. This seems to be more satisfactory to the consumer than to bring his meter to the shop for the purpose of making the test, and in such circumstances it is not essential that absolute accuracy be attained.

NO. 124. What is the best method of increasing the pressure in the furthest lying street main system during the greatest consumption of gas from early lighting till 10 o'clock P. M.? After that no deficiency of pressure exists.

FRANK HELLEN:—*Install an exhauster at the works. Lay a small high pressure feed main from the exhauster* to the point where the greater pressure is required; this line to be used at high pressure only during the period of greatest consumption. It can then be used to supply consumers where there are no other mains in the street, provided house regulators are installed.

R. B. BROWN:—Use a loop of pumping main about the town, connecting all holders and generating stations, from which radiate feed mains to the centers of weak points in the district. At the ends of each of these mains locate governor stations, consisting of two balance governors in a pit in the street. The pressure on a pumping system of this type can be regulated from day to day to just cover the requirements at the weakest end for each hour of the twenty-four, resulting in a minimum of power requirement and allowing of the use of the total holder capacity to the greatest possible advantage.

J. H. ENRIGHT:—Not knowing your output per day, the size and carrying capacity of mains, and ability of same to equalize pressure, holder pressure, etc., I would suggest your having a practical gas man make an inspection.

IRVIN BUTTERWORTH:—A special feeder main to the low pressure district, equipped, if necessary, with a fan blower or a high pressure pump.

WALTON FORSTALL:—This is another question the answer to which depends almost entirely upon local conditions. If there is not apt to be, in the near future, any need for enlarging the street main system between the works and the point needing "boosting," it may prove more economical to raise its pressure by laying a special feeding main of wrought iron for pressures ranging up to forty or fifty pounds per square inch, or a larger main of cast iron for pressures up to eighty inches of water furnished by a fan blower, than it would be to get the pressure in the ordinary way by enlarging the distribution system. However in estimating on the relative cost of straight distribution vs. "boosting," one must be very careful to allow enough for contingencies in the latter case, otherwise an estimated saving may prove an actual loss after some years' working of a "booster." In most large cities, until the size of the main needed for straight distribution gets very large (say over thirty-six inches) and its length very long (say over three miles), there is, considering the greater uncertainty of the services, nothing very attractive in the "booster" proposition. where there are in use pumping mains from manufacturing to holder stations, there is afforded an excellent opportunity to boost pressures by feeding direct from these pumping mains into the

M. N. LATTA:—This company (Charlotte Electric Railway, Light & Power Co.) is now running what the writer terms a "booster" line whereby a high pressure, four-inch main is brought from the works some miles away and tapped into the center of distribution. This line is under control of a non-automatic governor directed by compressed air from the company's office.

J. D. SHATTUCK:—The pressure in outlying districts may be increased by a district holder, or by high pressure line, or by combination of both. The selection of any one of the three systems depends upon the quantity of gas to be delivered during the hours when the pressure is weak and the distance from the manufacturing plant. A very cheap installation of say two-inch pipe, would feed with a small compressor a considerable consumption.

GEO. F. GOODNOW:—A practical method of increasing the pressure in areas which are too low during the hours of greatest consumption is to run a high pressure main of suitable size to these points with regulators placed in man-holes under the street. These regulators can be so adjusted as to feed the proper amount of gas to maintain the desired pressure. The gas can be transported any distance with gas compressors at the works and at whatever pressure is desired, say 20 to 30 pounds. The expense of such increase in capacity for such districts would be much less than increasing the present low pressure mains.

E. M. OSBOURNE:—Use an exhauster with direct line to suburb. In Pullman this is done by means of a small holder near suburb, which is filled during the day and turned on when the load is needed, thus equalizing the pressure nicely.

No. 125. Is there any effectual way of modifying a street governor to prevent a rise of pressure when little or no gas is being consumed beyond it?

EDITOR:—If the valves of a gas governor are not tight, the pressure on the outlet side of the governor will practically be the same as on the inlet side of the governor if the gas used does not exceed the leakage past the valve, hence the answer to the question is—a tight governor valve.

No. 126. What are the relative values of methyl alcohol and methyl aceton for clearing services of ice and naphthalene?

H. B. HARROP:—Experiments made in these laboratories on a sample of commercial acetone and a sample of wood alcohol of the market, showed the alcohol to be more effective in melting ice than the acetone by the ratio of 1.32 to 1.00, volume for volume. The solvent power of naphthalene at 32 degrees F. was in favor of the acetone by 5.07 to 1.00.

No. 127. How can gas services be best protected from freezing where they enter under sidewalks exposed to weather, at the same time guarding against water in cellars?

J. J. KNIGHT:—I have had the most success at the least expense by seeing to it that the pipe was large, did not come in contact with stone, and was wrapped with several thicknesses of newspaper.

R. SHACKLETTE:—Use a larger pipe at the exposed point.

ALTON LIGHT & TRACTION CO.:—Gas services where exposed to extreme temperatures should be protected similarly to heating pipes.

E. J. Sherwood:—We find that gas services can be prevented from freezing by covering them thoroughly with hair felt.

Jacob D. Von Maur:—I have never had a case of frozen service and so have not been called upon to furnish a remedy. I would suggest boring the service and surrounding it with some non-conducting material, such as sawdust, or wrapping the service with hair felt.

Editor:—Freezing of gas service pipes is due to conduction of heat from the gas to the walls of the service or main and from there to the surrounding medium, which is generally air. The drop of the temperature of the gas lessens its vapor-carrying capacity, causing the excess vapor to deposit, as a rule, as frost crystals. Continued cold weather will cause this formation to increase until the conductivity of the pipe is at least seriously hampered. There are several remedies for this. The usual one is to wrap the pipe with some sort of non-conducting material. This lessens the quantity of heat passing outward from the gas through the walls of the pipe, but is not a desirable or effective means to obviate trouble from freezing. Generally a non-conducting material is simply some material imprisoning air in a great number of finely divided air cells. The deposition of frost on the inside of the pipe is itself a very good non-conductor, and by enlarging the pipe at the point where the freezing occurs, especially where this is service pipe crossing an areaway, the trouble can be eliminated for the reason that a larged sized pipe gives a much larger surface for this frost to deposit over without congesting the flow of the gas, and it gradually increases until the transfer of heat from the gas outward is negligible. The only permanent remedy I know of for freezing is to sufficiently enlarge the size of the pipe or else rob the gas of its vapor before reaching the critical location.

No. 128. We have about one and a half miles of 4-inch and 6-inch paper gas mains. If others are using paper gas mains, would like to know their experience, as to durability, etc. Our mains have been in about six years.

No. 129. What substance or chemical is there in sand or fine ashes to attract electrolytic action? It has been noted that pipes give out more quickly when surrounded with sand than with any other substance.

J. J. KNIGHT:—Our experience is that pipe laid in sand is not affected as stated. Our trouble has been confined to heavy, damp, black soils entirely. Cinders, coke breeze, and ashes contain salts, which will attack iron and destroy it very soon.

W. M. SITES:—Reference: *American Gas Light Journal*, June 16th, 1902, page 874; Sept. 30th, 1901, page 526.

No. 130. If a gas main is laid parallel with a trolley track and service pipes are laid to dwellings on the opposite side of street and the outside surface of the service pipes are thoroughly cemented from the main to the house, then a saddle placed on the main and bolted tight, then a piece of pipe screwed into the saddle (which would be a dead end) and laid so the outer end would be one foot from the rail and one foot below the surface of the street, will this prevent the electric current from leaving the main at any other points within a distance of one hundred feet on each side of saddle?

J. H. HAGERTY:—Not if there is a path of less resistance through the earth at some other point.

No. 131. Is wood alcohol better than grain alcohol for cleaning gas pipes?

J. H. HAGERTY:—It is probably not better, but is cheaper and the fitters can't drink it.

F. W. BLOWERS:—Our experience this winter has demonstrated that grain alcohol is far superior to wood alcohol for cleaning service pipes of frost, and on account of the smaller quantity necessary to do the work, it is as cheap.

OFFICE METHODS AND ACCOUNTING.

No. 151. What are the advantages and objections to the uniform system of accounts recommended by the American Gas Light Association?

J. J. KNIGHT:—The system recommended is prolix, and this is both its advantage and objection. While probably ideal for large companies, it is absurd for small ones, and as one-half of the gas companies are in cities of less than 10,000 inhabitants, and half of these in cities of less than 5,000, the system will probably not be used uniformly.

JOHN T. BRADY:—I think the disadvantages more than offset the advantages in the system of accounts recommended by this Association. It is very true that the Committee in preparing this work had difficulties to contend with, which were undoubtedly increased by the failure of disinterested companies to lend their views on the subject. For this reason I do not care to enter into any detail of criticism other than to express the conviction that the bound ledger form for gas bill charges should be replaced by the loose leaf ledger system, the latter to all intents and purposes being the modern and approved method of keeping these accounts. I might also comment upon the advisability of using the meter slips as recommended. The reading for each individual month should be made detachable in order to prevent the meter reader from guessing at the true reading, by reason of having the previous month's reading to guide him. Not only is this an objectionable feature in itself, but there is opportunity afforded an unreliable employee to return a fictitious reading whenever entrance to a given address could not be had at the regular time of reading meters. The readings for past months should be preserved by the bookkeepers for the purpose of reference in all disputed bills.

W. A. ALDRICH:—It has some advantages, but many more disadvantages, but as we were invited to send in suggestions to the committee which would have received very careful consideration, we have no right to criticise the admirable work—unthankful as it was—of the gentlemen who devoted so much of their valuable time to our interests. Criticism would be very bad taste.

No. 152. What sort of a record best lends itself to keeping track of stock of materials?

C. N. Jelliffe:—To my mind, a loose leaf record best lends itself to keeping track of materials and supplies. By the use of such a record, materials can be kept in groups, such as pipe, fittings, appliances, etc., also by sizes and numbers, without the necessity of changing the order when a leaf is filled. This does away with the index feature, which is always a requirement where a bound book is used.

The leaves for a record of this kind should be so ruled as to show date, quantity or number and cost of materials used or sold. By the use of cumulative footings, it is then possible to tell at a glance the quantity on hand, also the value.

This is not only valuable as an inventory record, but valuable to the purchasing agent as well in determining the necessity of purchases, it being possible for him to verify the "stock on hand" as stated by the superintendent's requisition for purchases with the balances as shown by the record, thereby opening up an investigation if differences occur.

New York & Richmond Gas Company:—We use a card index, sample of which is appended, which speaks for itself. (See page 350.)

Walton Forstall:—A card record, providing an individual card for each article in stock, is by far the most convenient.

M. N. Latta:—Our store-room is supplied with lockers, shelves, hutches, etc., for each article of stock, on the outside of which is a label. The quantity of articles originally placed in receptacle is noted upon the label in one column, all articles taken out by the store clerk are noted in the opposite column, and the deduction made, the running balance always showing stock on hand. (See page 351.)

John T. Brady:—A running account showing quantity and cost, the receipts being posted in columns for quantity and cost, and each disbursement entered in opposite columns in quantity and cost, so that a running balance may be kept at all times to show amount on hand in value and quantity. This requires an account of each article in stock.

H. W. Thompson:—For keeping track of stock materials I would suggest that a loose leaf ledger ruled so as to show a daily balance in quantity and value. Carrying a balance every day would not take much more time than the old method and would

ARTICLE...................... **CLASSIFICATION**................. **MINIMUM STOCK**.................

O. H. or Rec'd	Date	Stoves	Serv.	Fixs	Dist.	Wels.				O. H. or Rec'd	Date	Stoves		Fixs	Dist.	Wels.			

be a great advantage. By using the loose leaf you can arrange your books so that an index is hardly necessary. For instance, arrange all the fittings in one part of the book alphabetically, starting with bushings, and rearrange each set of fittings according to the sizes. The stoves can be arranged in the same way, also the miscellaneous stock. All entries must be made in the above book from requisitions drawn on the storekeeper. The stock clerk will enter and price these requisitions and then turn

CLASS OF FITTING.

Filled......................**19**...

O L B CO 5-6-05 1M

TAKEN OUT.	ON HAND.

them over to the general bookkeeper, who will charge them to the proper accounts. Stocks received can be entered on similar requisitions by the storekeeper, showing from whom the material was received. These requisitions should be on different colored boards, so that the stock clerk will not confuse them with the disbursement requisitions. These requisitions will be entered by the stock clerk the same as the disbursement requisitions. All bills showing material charged to stock should be turned over to the stock clerk to verify his books and get the value of the stock received.

B. C. Cobb:—If large and varied supply stocks are necessary, the loose sheet ledger and bin card system.

APPLIANCES.

No. 201. Are gas engines used anywhere for refrigeration purposes?

B. F. BULLOCK:—Yes; Swift & Co. in their packing plant at Newport News, Va., have a 28 H. P. gas engine running their refrigerator plant.

W. E. BROWN:—Yes, in New Westminster, B. C., and they answer perfectly.

J. D. SHATTUCK:—The Brown-Cochran Co., of Loraine, Ohio, makes a very compact and complete gas engine refrigerator plant.

J. WALLACE SCHAEFFER:—Yes.

WALTER THOMAS:—There is a 22 H. P. Crossley gas engine operating refrigeration machinery at Vancouver, B. C., during the last three years; also a 22 H. P., same make, doing same work at New Westminster, B. C., during last year.

The gas engine at Vancouver operates a 6-ton ice, or 12-ton refrigerating compressor, the cost and time of operation being as follows:

1902—Cost per hour	$0.323
Ran engine 1,899 hours.	
1903—Cost per hour	$0.309
Ran engine 1,987 hours.	

F. W. STONE:—Cold storage plant of H. E. Horne & Co., Greenville, Pa.

H. H. POWELL:—I have had a 20 H. P. gas engine driving an ammonia plant in a cheese and butter cold storage station for the past two years. The owners are well satisfied.

No. 202. Should gas companies push gas grates or gas heaters for warming rooms?

W. E. BROWN:—We have had most success with flueless heaters, using the small yellow flame heaters for bedrooms or occasional use, and the Bunsen blue flame type for offices or continual use. There is great room for improvement in all gas-heating apparatus, and an immense trade will be opened up when the perfect heater makes its appearance.

J. H. ENRIGHT:—As a general proposition I believe it best to push good, practical heaters using illuminating gas for the heating of bed and bathrooms. Heaters of this kind can be attached very easily in almost any part of a home, and can be made popular for all periodical work even where gas is sold at $1.50 per M.

F. R. PERSONS:—Push the sale of heaters. It is a far better trade than grates, which are usually required to heat a larger area.

R. SHACKLETTE:—I believe it is preferable to push gas heaters, as the first cost is within the reach of all, and because they can be moved from place to place as occasion demands.

FRED H. BECK:—I think gas heaters would be best to push for warming rooms, and they should be used with the luminous flame burner.

WALTER M. BLINKS:—Their merits and limitations should be fully explained and the sale pushed where they answer the required conditions, not otherwise.

F. LANGWITH:—While the grate is most healthful, the heater is the most efficient and from the point of economy should have the preference.

H. H. POWELL:—The sale of gas grates is very desirable. They afford a means of quickly and economically giving a cheery welcome to one's friends, that is appreciated by the ladies—which helps us.

F. W. STONE:—I do not believe that it pays to push any kind of appliance that does not give a consumer satisfaction. If a person is willing to pay the extra price, a gas grate is very nice-looking and has a cheerful appearance in a room, but as a heating appliance it is not a success, as the heat simply radiates into the room from the front. If your consumer wishes to use gas for heating, pure and simple, it is better to advocate the use of a gas heater.

ALTON LIGHT & TRACTION CO.:—This company has found it advisable to push both gas grates and gas heaters.

IRVIN BUTTERWORTH:—My idea is that the company should, in the case of each house, first try to have gas grates installed for permanent use in moderately cold weather when the furnace is not in operation, but failing to get them put in, the company should then push the portable heaters. I doubt, however, if gas companies are profited by either form of heater when used at the time of the annual peak.

W. Hellen:—If there is a fire-place in the room, gas grates should be recommended.

S. Tully Willson:—While it is probable that a gas grate does not heat a room as well as a stove using the same amount of gas, it has the great advantage of being a permanency, or requiring little space, of being more or less ornamental, and of requiring no visible flue. Assuming a good grate which will produce no odor or soot and is not excessively over-ventilated, it is apt to be used more and remain in use longer than a stove, which will be put away in the summer and lost track of or damaged. On the first chilly evening in the fall, the grate is lighted, while the stove is at least not at hand.

No. 203. What is the secret of high efficiency incandescent gas lighting by means of high pressure?

J. J. Knight:—A difficult question to answer briefly. The delivery of gas in small volume under high pressure results in better aeration and greater energy of combustion.

W. Hellen:—In incandescent gas burners used with high pressure, efficiency is much higher on account of the mantle being thoroughly filled.

James Ferrier:—The higher pressure increases the injecting power of the gas, thus increasing the proportion of oxygen. With an increased supply of oxygen fewer intermediate compounds are formed, causing a reduction of the space within which combustion is completed, *i. e.*, the flame. As temperature may be generally regarded as heat space, we have an increased temperature resulting in a more intense incandescence of the mantle.

Donald Davidson:—Gas burned in a Bunsen burner at high pressure produces a much higher temperature than at low pressure. The higher the temperature of the mantle the greater the per cent. of radiation is light and the greater the efficiency.

Irvin Butterworth:—The securing of quick combustion of the gas by means of more rapid and intimate admixture of air therewith, producing a more intense heat, thus making the mantle hotter and therefore brighter.

No. 204. Which is the more efficient, an instantaneous or a circulating water heater?

Jno. P. Reinecke:—The instantaneous heater must be more efficient because of the natural and necessary construction, which is a large amount of fire surface. In order to heat a given amount of water in any specific time, several conditions are essential.

First—The amount of heating surface exposed on one side to the fire, and the other being in direct contact with the water to be heated, must be of sufficient area to impart the desired number of heat units to the water during the time allotted for passage of the water.

As a capacity of each square inch of fire surface is limited in proportion to temperature of the water entering the heater and that of the fuel, it is therefore obvious that a large amount of surface must be used in the construction of the instantaneous water heater, and when properly placed, the greater the surface the more efficient the heater will necessarily be.

Second—The instantaneous heater does not require the storing of any water, it being heated upon demand, and only such amount of fuel is used as required to heat the water drawn, and when desired quantity of water has been obtained, the consumption of fuel immediately ceases.

In comparing the circulating heater, we find the motion of the water through the heater is by gravity, due to heat applied to fire surface of the heater, thus transmitted to the water and causing the circulation of the water. This motion is naturally slow and limited, also requiring a constant fire in the heater in order to have hot water at command.

We must also consider the heat given off by radiation from the surface of the storage tank and the circulation pipes, which we find to average about 2° per degree between the temperature of the hot water and that of the air surrounding same.

(The accuracy of above is dependent upon the condition of surface of tank, as to whether it is a plain, painted or polished surface. A number of authorities give a variation from 1.25° to 2.43° for various kinds of surfaces, 2° being considered a fair average for vertical surfaces.)

Therefore, this radiation must necessarily be a constant source for loss of heat.

The automatic instantaneous water heater having capacity to supply water at any fixture in any part of a building, is therefore the most efficient and at the same time the most desirable heater to be used and should be recommended by all gas companies.

The highest efficiency ordinarily obtained from a circulating heater is rarely above 60 per cent. and a majority of those on the market at the present time do not reach 50 per cent., while the efficiency of the automatic instantaneous heater averages about 75 per cent., due to the large amount of fire surface to which the fuel is applied.

In considering the above named points, it therefore seems clear that the instantaneous water heater is more efficient than the circulating heater.

H. S. HUMPHREY:—The best instantaneous water heater will utilize from 80 to 90 per cent. of the heat units in the gas; that is, will transfer that per cent. of the heat in the gas to the water, and are much more efficient than the circulating water heater.

ALTON LIGHT & TRACTION CO.:—This company has found circulating water heaters more satisfactory than instantaneous heaters, even though hot water can be secured more quickly with the instantaneous heater.

W. E. BROWN:—Circulating. Instantaneous heaters in inexperienced hands give trouble.

W. HELLEN:—A circulating water heater.

W. A. ALDRICH:—For general purposes, the circulating heater is decidedly the better. For bathroom, the instantaneous is preferable.

S. TULLY WILLSON:—There are two classes of instantaneous and one of circulating water heaters, with a great variety in each class.

Considering only the best of each kind, the direct instantaneous shows the possibility of the highest efficiency under usual conditions, that is, where water of not over 120 degrees temperature is required. The water to be heated is sprayed directly through the hot products of combustion, giving an immense heating surface with no intervening medium to transfer the heat. Much of the vapor formed by the combustion of the hydrogen in the gas is condensed, making a saving not attempted, as a rule, in the circulating or indirect instantaneous heaters. There are other advantages and also disadvantages, as question No. 205 might indicate, but efficiency only is here considered.

The indirect heaters, both circulating and instantaneous, might here be classed together, for their efficiencies depend on the same details, viz., heating surface per foot of gas per hour, the conductivity of the metal which confines the water, the mechanical arrangement of the whole, proper ventilation, combustion and flue temperature. The field for circulating water heaters being much the larger, there has been an incentive for more exertion in this direction, consequently greater progress has been made. As they do not require such large rates of gas consumption and are usually permitted to run a longer time, more heating per foot of gas is allowable, as the additional weight, or thermal capacity, is not so objectionable.

These points may not apply to every heater, but the standard makes, when efficiency only is considered, will stand in the following order: Direct, instantaneous, circulating, and indirect instantaneous.

No. 205. Is water from an instantaneous heater, where the flue products come in contact with the water, fit for cooking and kitchen work, and if not, what injurious matter does the water contain and to what extent?

H. S. HUMPHREY:—The water will absorb a small percentage of the products of imperfect and perfect combustion, viz., carbon monoxide and carbon dioxide, and while a person might find it distasteful, there probably would be no injurious effects whatever from drinking the water.

Many instantaneous water heaters are so constructed as to keep the products of combustion from the water, and these are generally used where the water is to be used for drinking or cooking purposes.

ALTON LIGHT & TRACTION CO.:—This company has found the water from an instantaneous heater, where the flue products come in contact with the water, unfit for cooking, though no test was made to determine just what was the injurious matter it contained and to what extent.

CLARENCE S. LOMAX:—The water from an instantaneous water heater, where the flue products come in contact with the water, is not fit for cooking or the making of tea, coffee or cocoa, for the reason that the gases during combustion are chilled and a certain amount of acrolein and other similar compounds are dissolved in the water, producing a bad taste in the food and injury to the stomach receiving it.

W. HELLEN:—No. Water heated in an instantaneous heater should not be recommended for cooking on account of the verdigris which forms on the inside of the heater.

No. 206. What is the best method of setting up stoves? Should the delivery, gas piping, flue piping and meter setting all be done by the same gang or by different gangs of men?

E. C. WHITE:—Think the same gang should deliver, do piping and set meter for range.

J. H. ENRIGHT:—A good shop man, with one assistant, should place the stove complete and ready for use. Should there be several orders on hand, put on additional help, as I believe it good business policy to set up stoves on the date they are sold if it is possible to do so.

FRANK HELLEN:—We have tried several ways to reduce the cost of gas fitting and have adopted the present system as least expensive.

One man is constantly employed delivering the pipe, fittings and meters on the jobs and picking up all the remaining pipe and fittings left on completed jobs.

The gas fitter, with necessary tools including stock and dies and small vise, connects the stove and sets the meter. (No helper is regularly employed on this work.)

The completed work is inspected by the same inspector who apportions the work to the fitter, and aims to keep him in one locality as much as possible to obviate unnecessary expense of moving. Should a particular job require the services of a helper (which is very seldom), the shop inspector, acting in the capacity of foreman, notifies the shop foreman, who sends out a helper for this job.

Gas fitters do not come to shop except on pay days, so they can put in ten hours' work in gas fitting and the company saves the time that would otherwise be lost in trips to and fro between the shop and their respective jobs.

W. E. BROWN:—Depends upon the size of the company. In large works it will be best for meter setting and main work to be done by separate gangs.

IRVIN BUTTERWORTH:—As much as possible of this work should be done by one and the same gang of men.

WALTON FORSTALL:—Our experience in Philadelphia, in connecting at times as many as 500 gas stoves a day, 200 being connected from one shop, makes us believe that when on a large scale, this work of setting a gas stove can be done must economically by being subdivided between various gangs of men. We deliver by wagon the stove, four lengths of pipe and a stove box containing all the necessary fittings. The stove fitter never reports to the shop, but proceeds at first from house to house, according to a program furnished him by his inspector. If a meter is to be set, this work is done from a wagon by the regular men. After the stove work is completed, a wagon calls for the stove box and surplus pipe.

W. HELLEN:—It is immaterial who makes the delivery, but the rest of the work should be done by the same gang of men.

No. 207. What are the arguments for and against the use of flueless gas heaters for rooms?

C. HENRY IRWIN:—Arguments for—Heats quickly, as none of the heat is carried off through the flue.

Heaters of ordinary size can readily be moved from one room to another.

They can be connected and disconnected with rubber tubing with very little trouble.

Arguments against—If connected with rubber tubing, I have known of cases where they have taken fire and melted the rubber where it is connected on the heater, and if no person had been present a fire would have taken place.

They are bad for the inexperienced who close the room up with no ventilation. All the oxygen is consumed out of the air and one soon feels depressed with an aching head.

Again, people connect them on chandeliers from the center of the room where there is not sufficient supply for the heater; thus the heater is condemned.

WALTER M. BLINKS:—A flueless heater is portable and cheap, it discharges all the heat into the room but also products of combustion, CO_2 and water vapor. There is no objection to this where heaters are used intermittently for short intervals and the advantages above mentioned recommend this construction. Where stoves are in service for considerable length of time they should always be connected with a flue. The heat lost in the chimney will make it necessary to have greater capacity in heater.

W. E. BROWN:—Flueless stoves are all right for offices that are not entirely closed in or where the users are in and out. If used all the time in closed-in offices, the air becomes close and injurious.

IRVIN BUTTERWORTH:—The chief favorable arguments are that they give an efficiency of 100 per ecnt., can be used in rooms unprovided with flues, and in dry climates, with well purified gas, they give good satisfaction. The chief adverse arguments are that in damp climates the moisture added by them is objectionable, and with imperfectly purified gas they produce unpleasant odors or "stuffiness," to overcome which excessive ventilation is necessary, reducing the economy.

F. A. CRESSEY, JR. :—Flueless gas heaters are much easier sold but are sure to dampen the room.

W. HELLEN :—The argument in favor of a flueless heater is that it may be easily moved from one room to another, and the argument for a heater with flue connection is that there will be no odor in the room.

S. TULLY WILSON :—The flueless gas room-heater may have the advantages of being portable, of giving 100 per cent. of the heat of the gas to the room and of having no unsightly flue pipe. This last merit is also a demerit, for the greatest fault of the flueless stove is the discharging of the products of combustion, which contains carbonic acid gas and moisture, into the room.

DONALD DAVIDSON :—In flueless heaters expense of flue is saved and they are more portable. They are more efficient, as all heat produced remains in room. The disadvantages are formation of CO_2 and usually a small amount of SO_2 and sometimes CO, which contaminates the air of the room.

JAMES FERRIER :—Arguments for—(1) Utilization of all the heat produced. (2) Cremation of any noxious germs that may be present in the atmosphere.

Arguments against—(1) Vitiation of the atmosphere, rendering it non-hygienic. (2) Increased danger of asphyxiation in case of the stove being accidentally extinguished.

The writer thinks that the arguments against are more potent than those for such heaters. A common error made in this connection is to regard CO_2 as merely a dilutent of the atmosphere. That it is directly toxic when it exceeds a certain per cent. is the opinion of the highest medical authorities on the subject. What that per cent. is, the writer does not undertake to say.

No. 208. Is the use of separate shut-off cocks for gas ranges desirable?

E. M. OSBOURNE :—We have never considered a stove properly set without having a stop-cock, for the following reasons:

First—If the burners get out of order, or are broken when there is no one around who can fix them, gas can be shut off by stop-cock at the range instead of at the meter, thus enabling consumer to use gas for illuminating while range it out of order.

Second—It is used as a safety precaution where children are in the home, who might accidentally or purposely open the easily turned burner-cocks of the range.

Third—It is convenient when changing the position of the range or temporarily removing it during house-cleaning.

There are many reasons for using this inexpensive stop-cock, and the fact that our patrons request it, is perhaps the strongest one, as we wish to please them when it can be so easily done.

F. R. PERSONS:—Yes, for the reason that it is always desirable to be able to shut off any department from a general line of consumption. The practice is not general because gas companies usually install the stove "free" and thus save expense of cock.

PAUL CHALLIS:—Yes, chiefly as a precautionary measure. The parties operating gas ranges should be instructed that the shut-off cock is for use at any time an accident may occur to the burner cocks on the stove, or for any other reason that they are unable to stop the escape of gas about the range. In case it is desired to make repairs to the burner cocks on the range or disconnect it for any reason, the shut-off cock is especially desirable when the meter or service cock is quite distant or in an inaccessible location.

W. V. SPINNING:—Yes, for the following reasons:

1. Safety. In case children are left alone in the house, they are very likely to try and "light the fire," being familiar by observation with the way it is done and the temptation being great to turn it on and off. As they are not so familiar with the working of a shut-off cock, its installation would prevent this danger in a large measure.

2. Convenience. When repairs to stove are necessary, in case a water heater or bathroom heater is in use, there is no necessity of shutting off at meter or curb. In using a cap quite an amount of gas ecapes in disconnecting and putting it on, creating apprehension in the minds of the consumers as to danger and also amount of gas lost which will appear on the bill at the end of the month.

3. Gives the consumer confidence in the carefulness of the gas company and keep them on our side, which pays every time.

W. C. Hughey:—Cannot see any advantage in stop-cock and request is seldom made for one by a consumer.

C. Henry Irwin:—Yes. Often a leak will occur about a burner cock or some part of the stove that is not easy to get at and is quite difficult to detect, and is only noticeable at night when the kitchen is closed up tightly. Consumers oftentimes ask to have them put on, as the servants use the gas range unnecessarily and in case the range needs repair or has to be taken down to renew the floor covering, they are very convenient.

J. J. Knight:—Yes, a shut-off back of the stove is a safeguard and convenience which appeals to the consumer, and has but slight objectionable features.

Henry S. Whipple:—No it increases the danger of gas exploding in the oven.

Philo Jones:—Yes. First, while illuminating burners are out of reach of small children, as much cannot be said of the valves of a gas range. Therefore do not use a long handle shut-off cock, but one with a detachable handle which can be hung out of reach of the children. Second, to facilitate repairs to gas range without necessity of shutting gas off from entire building.

Alton Light & Traction Co.:—Our company considers separate shut-off cocks desirable.

E. J. Sherwood:—The use of separate shut-off cocks for gas ranges is not desirable. The burner cocks on the range are liable to be left open when the shut-off cock is used to shut the gas off, and when it is turned on again, if the burners are forgotten, an explosion will occur.

B. F. Bullock:—It depends greatly upon the location of the range, or if there are children or not. As a general policy, I fail to see where the advantages justify the extra expense.

Irvin Butterworth:—No. They add to the cost and increase the danger of explosions while the stop-cock near the meter is sufficient.

F. A. Cressey, Jr.:—Only where there are children.

Walton Forstall:—I never have felt that the expense of a separate cock on the stove line was justified by any use that would be made of it, and if it is placed, as generally, near the stove, it may become a source of explosions, because of burner cocks opened and left on, with line cock shut, and burner cocks forgotten when line cock is turned on.

W. Hellen:—Yes, a gas range should have a separate shut-off cock.

W. A. Aldrich:—Most decidedly; many explosions have been prevented by having a shut-off in the supply pipe to the range.

B. C. Cobb:—Yes, that the range may be cut off if necessary, leaving other appliances still connected.

Editor:—I believe a separate shut-off cock for gas ranges is never desirable unless there is some direct and specific reason for its use. Shut-off cocks, to my mind, have caused ten explosions where they have prevented a single one. The operator of the stove will frequently shut off the oven burners and all by means of the general shut-off cock and later will go back to the range and light one of the top burners and cause an explosion which will probably wreck the stove if it does nothing worse. Very little chance of an explosion presents itself in any other way. If the oven burner is turned on by children, the operator notices the odor before he or she have occasion to light the stove, but where the shut-off cock is turned on and the top burners of the stove lighted, the escape of the gas through the oven burners is not apt to be noticed until an explosion occurs. Some of the reasons advanced for the use of general shut-off cocks would, if valid, require the use of general shut-off cocks on each fixture of an illuminating system.

No. 209. Does risk of explosion follow the use of unprotected burners in japanning or enameling ovens, and what is a sure preventive against this risk?

H. S. Humphrey:—For enameling, a blow pipe being used, accidents might result from carelessness in lighting the gas.

For japanning where a temperature of only about 200 degrees is required, the oven should be constructed so that the japan cannot fall on the burners, but into a cast iron pan, the pan removed and cleaned often so only a small amount can accumulate, and then should say no danger would exist.

Clarence S. Lomax:—I have had cases of explosion due to the use of unprotected valves and burners in ovens. I think that a protection of the valve and mixer with a gauze cover would help this matter.

W. Hellen:—Yes, somewhat. A good preventive is to have a piece of sheet iron about six inches wide extend along over the top of the gas jets and the burners. This prevents the dripping from the japanning coming in direct contact with the blaze. The burners should be provided with an independent pilot burner, as the burners are sometimes turned so low they are liable to go out.

No. 210. Is gas being successfully used for cremation, and in what form of apparatus?

Walter M. Blinks:—The papers frequently report such instances. Apparatus usually described; a frame building, ordinary natural gas appliance of home construction, sudden rise in line pressure during the night, and the crematory is in full operation.

No. 211. Does it pay to push hot plates?

C. Henry Irwin:—Yes. I can recall a number of cases where our consumers were educated to cook by gas on a hot plate and afterwards purchased a range. Where ranges are not rented and the parties are tenants for a short time, a hot plate is the only appliance saleable.

Alton Light & Traction Co.:—The experience of this company has been that standard sixteen and eighteen-inch, four-hole ranges are most desirable, though we handle hot plates to meet the requirements of certain purchasers.

Philo Jones:—We can usually sell a range instead, thus probably increasing the gas consumption more than if a hot plate be sold. However, it is better to sell the hot plate now, and later possibly the range to the same consumer, than to fail to obtain a customer by refusing to sell a hot plate.

W. E. Brown:—Certainly. Begin with hot plates which always gives satisfaction and are a powerful lever for securing gas lighting, etc.

Irvin Butterworth:—I believe not, except possibly in cities having very migratory populations. They militate against the introduction and use of the maximum number of gas ranges.

James Ferrier:—This is a local question. The writer found at one time that owing to the objection of placing ranges in the hands of colored cooks, as much gas was used per hot plate as per range. Each was used only in the absence of the cook. Then it paid to push hot plates. The advent of the slot meter has modified these conditions.

W. Hellen:—Yes, as the gas range will eventually take the place of the hot plate, and the hot plate will replace the wood and gasoline stove in the laundry.

F. R. PERSONS:—Yes, as an education for gas consumer.

E. M. OSBOURNE:—Push whatever sells best, with an eye always to establishing a permanent demand for the commodity.

R. SHACKLETTE:—No, save them for the customer who will not have anything else.

B. C. COBB:—Only from an educational standpoint, and to get new consumers who will not purchase ranges in town where the gas business has not been pushed.

No. 212. Give us some method of lighting store windows by gas which will avoid sweating of windows.

J. J. KNIGHT:—The sweating and frosting of show windows can be avoided by locating the heating apparatus of the store near the window, and this is the proper place for it anyway. The warmed air rushes to the window and warms the glass. If window is enclosed, it should be ventilated by openings at the top and bottom of the enclosure.

It certainly is a mistake to suppose that the trouble is caused by burning gas in the window or store.

W. E. BROWN:—This is entirely a matter of proper ventilation. Without this, windows will sweat, with electric lights or no lights, provided the body of the store is warmed. Close the window in air tight on the store side, then cut about 1½ inches all along the bottom of the window to allow the street air to come in, cut out 2 inches along the top to allow hot air from lamps to pass out, and, if gas lights are kept high the hot air will not sweat the windows.

F. A. CRESSEY, JR.:—Have vent holes above and below the window next to the glass so as to have a free circulation of air next to the glass.

W. HELLEN:—Try boring a row of holes along the bottom of the window and also a row at the top. Keeping a small electric fan going on the inside of the window is also a good preventive.

B. W. PERKINS:—Exclude all indoor air from the window by closing in. Ventilate from the outside, access to window to be had through tightly fitted door. If this method is followed, the glass will be clear during the coldest weather.

F. R. PERSONS:—Box the window and use glass roof. Put lights over the glass with strong reflectors. Heat the windows (enclosed boxing) by small gas heating stove.

W. A. ALDRICH:—Sweating cannot be altogether avoided. It can be reduced to a minimum by cutting a circular hole in the top of the enclosed window, and placing a gas arc in the opening with a reflector—the heat given off thus is discharged outside. The writer finds this method very satisfactory. It certainly prevents the products of combustion being deposited on the window.

S. TULLY WILLSON:—Carry off the products of combustion.

No. 213. What is the reason the average gas manager finds it hard to place gas engines even where the price of gas is low?

H. H. GANSER:—Owing to the high price of the appliances.

J. J. KNIGHT:—Because, for power, gas cannot compete with electricity for convenience, or with gasoline for cost; convenience or cost decides the question with the consumer, allowing all to be equally efficient.

CLARENCE S. LOMAX:—This question is answered in general by the fact that during the last few years the average price of gasoline has made it a cheaper motive power than the average price of gas, and this company has induced many manufacturers to use the gasoline engine in preference to gas.

WALTER THOMAS:—First—Because he does not select the best machine on the market regardless of cost.

Second—On account of not being able to give reliable data as regards consumption, etc., etc.

Third—The initial cost is high, and gas companies, as a rule, are not willing to invest a little money and distribute payment over a considerable period.

Fourth—He is not sufficiently sanguine himself.

Fifth—He does not, as a rule, use the engines himself.

ALTON LIGHT & TRACTION CO.:—This company has always considered that the electric motor was more advantageous than the gas engine, especially as the original cost is less, and experience required to operate much less.

FRANK HELLEN:—The trouble is often due to the misrepresentations on the part of the salesman, who in his eagerness to "do business," claims that the engine requires very little attention and that any old man, woman or infant can successfully operate it, and that it practically requires no attention whatever except starting and stopping. This is certainly a mistake, and the customer sooner or later arrives at the conclusion that somebody has deceived him, and his lost confidence in the salesman oftentimes results in lack of confidence in the engine.

When the engine is installed it runs "beautifully," and no particular attention is paid to it beyond starting and stopping, which is all the salesman claimed the engine required. Suddenly, without any apparent reason, the engine stops at the busiest hour of the day, and no one on the premises knows what the trouble is or how to start the engine. This may occur several times and eventually the owner of the engine wakes up, throws out the engine and emphatically condemns every infernal machine in the guise of a gas engine; and as a further relief to his mind, he informs all his friends and business acquaintances of his experience, and I do not blame him, for it is clearly the fault of the gas engine salesman.

Do not install a gas engine until it is thoroughly understood and indelibly impressed on the mind of the customer that a gas engine cannot be run by every "Tom, Dick and Harry" he may chance to have in his employ. Tell him frankly that it requires the attention of an experienced mechanic. Place such a man in charge of the engine and hold him personally responsible for the condition and management during working hours, and see that no one else handles the engine unless it is a substitute who has been properly instructed. Under such conditions the engine works satisfactorily and assists in selling others. I do not mean to say it will take all his attention, but the idea is to have a responsible man in charge.

J. H. ENRIGHT:—First—Because the price of gas engines is too high, as compared with cost of electric motors.

Second—Inclination of the public is more favorable to electric motors.

Third—If gas engines now in service are not carefully looked after by competent men, so that the service will be satisfactory, the consumer owning same cannot be depended on to recommend their use.

W. E. BROWN:—Because either he does not understand this important branch of the gas trade or because his employers will not allow him to take proper steps to secure this business. In a town of 6,000 population the writer has 18 engines running with gas at $1.25 and has replaced every electric motor though supplied by water company. For economy and steady running under fluctuating load, electric motors cannot compete with gas engines. Of above engines four are 25 brake horsepower.

IRVIN BUTTERWORTH:—Probably high first cost as compared with electric motors, lower efficiency on small loads, greater weight, and greater difficulty of installation.

JAMES FERRIER:—(1) Higher first cost compared to electric motors. (2) Difficulty in starting. (3) Vibration, rendering them unsuitable on upper floors. (4) Difficulty in obtaining repairs done in ordinary machine shops.

The writer would here mention a practice in vogue among some manufacturers which he thinks objectionable and which sometimes causes gas engines to be regarded with disfavor. The engines are often built and tested where the calorific value of the gas is high, and the tests are conducted by experts in the business. The highest brake power developed under such conditions is stamped on the engine, and it is sold as being of that power. The writer thinks that manufacturers should rate their engines at least ten per cent. below the power obtained under the conditions named.

HENRY S. WHIPPLE:—The low price made for electric current for power purposes; the smaller first cost of the motor, and the greater ease with which it is operated as compared with a gas engine of the same size.

E. HAASE:—The gas engine has a reputation that has been made for it to quite an extent by the unreliable, uneconomical makes of engines that have been put on the market in the past years. Poor engines, insufficient attention to the same, and difficulty in getting competent men to attend to troubles, have prepared a rough road for the introduction of even a good engine.

Our success in the introduction of gas engines began by demonstrating to the then users of gas engines that we had a man who knew something about engines, who made periodical visits to gas engines which were in use and remedied troubles. This man was an expert in gas engine troubles and his fame naturally spread.

We then determined upon an engine to be introduced by ourselves and selected one after exhaustive tests of all the engines offered. The engine we intended to introduce was advertised. The gas engine subject in general was kept before power users and we began to be consulted and engines were introduced. The engines that we introduced were carefully observed and troubles forestalled or remedied as soon as we were notified of the same. Our reputation for taking the troubles off our customers' hands has, more than anything else perhaps, secured us new sales. Even after the expiration of the guaranty period of one year engines are looked after.

The sizes most generally introduced vary from 15 to 20 horsepower. The places into which these sizes find their way are usually shops running on very small capital and it often requires the installation of the engine on a series of partial payments extending over one year. This plan of work enabled us to introduce a high grade engine against the field of all sorts of makes selling at a much lower price, and we quite have the business to ourselves.

W. HELLEN:—First, the cost of the engine. Second, so many users of gas engines require steam in the winter time to heat with, which they can procure from the steam plant, as well as power.

S. TULLY WILLSON:—There are many good gas engines on the market, but unfortunately there are few people who thoroughly understand them. In order to make more sales, the manufacturers of gas engines harp on their simplicity and the little care they require; as a consequence, they are put in the hands of men with little mechanical ability and do not get the attention requisite for satisfactory operation. The first time a screw gets loose or any adjustment is changed, the engine is a failure. If the average gas engine were as thoroughly understood and received half as much attention as a steam engine, it would soon be in much more general use.

A gas engine repair man recently stated that although he supposed there were some very poor gas engines on the market, he had never found one as yet which could not be made to operate satisfactorily.

W. A. ALDRICH:—Because the first cost of the gas engine is about four times the cost of an electric motor. The price of gas engines makes it almost impossible to compete against a motor even with cheap gas.

No. 214. Do not manufacturers of gas and gasoline engines give preference to gasoline over gas; if so, why?

J. J. KNIGHT:—In my opinion gasoline has no competitor in the matter of cost, and very naturally the manufacturer favors the article furnishing the largest field for business.

WALTER THOMAS:—Yes.

First—On account of a greater field for operation.

Second—Because purchasers of gasoline engines are usually isolated and cannot get electricity and have to make it work.

Third—Gas men, as a rule, do not push gas engines.

R. SHACKLETTE:—Apparently. I once secured an order to supply gas for three 50-horsepower engines to operate a scenic railway plant; but after the engines were ordered and the piping laid, the manufacturers induced the company to use gasoline instead.

E. M. OSBOURNE:—Yes. It is claimed least trouble is experienced with gasoline.

H. H. POWELL:—Because they don't have so many complaints from the purchasers as to the cost of operating, as users of gasoline are like the users of coal oil—few know what it costs them per month or year.

W. A. ALDRICH:—It is a positive fact that manufacturers of gas engines invariably push their gasoline engines in preference to gas engines. The writer suggests that their claim of 20 feet per horsepower in small engines cannot be substantiated. The question should be referred to a committee for investigation.

S. TULLY WILLSON:—There is no doubt they have good reason to do so. The field is very much larger and the same sized engine will develop more power with gasoline.

CLARENCE S. LOMAX:—See answer to question No. 213.

ORAL DISCUSSION.

MR. OSBOURNE:—I would like to have the editor's comment on that question.

MR. DOHERTY:—On the question as to whether the manufacturers of gas or gasoline engines do give preference to gasoline over gas; I will say I think they do. No one is so situated but they can use gasoline, although often they are so situated that it is a disadvantage to them in getting insurance if they do so. Engine manufacturers might simplify their methods of doing business and simplify the construction of their engines if they could build their engines for gasoline and gasoline alone. A great number of small internal combustion engines use gasoline because they are remote from cities and towns where they can obtain gas. They are used now by the farmer instead of a windmill, and are used for various purposes.

No. 215. Should the Ohio Gas Light Association appoint a committee for the purpose of testing gas appliances by some standard method, and report results to the members, so that they would know which is the most efficient?

Clarence S. Lomax:—I believe that the object can be obtained by the appointment of a committee to work in conjunction with a committee of physicists and chemists from scientific institutions in Ohio.

Fred H. Beck:—Yes.

Irvin Butterworth:—Yes. This would result in appliances being used of greater economy, thus increasing the credit, reputation and efficiency of gas for domestic and industrial purposes, and adding to the revenues of the gas companies.

W. Hellen:—Yes.

M. N. Latta:—Yes, most decidedly.

S. Tully Wilson:—There is a very large difference in the efficiency of different makes of gas appliances, and if tests are to be made, in justice to the manufacturer, these tests should certainly be standarized in such a way that the manufacturer may himself determine the inefficiencies of his appliances.

If each gas company should carry on a set of experiments to determine efficiencies by a standard method, some operators would be careless and the results inaccurate, while a committee might select persons capable of doing the work and obtain accurate results for the benefit of all members at a great saving of expense per company. The manufacturer who is a member of the Association would of course be greatly benefited, for should he find his appliances of very low efficiency, there is nothing to prevent his improving them. As the results of tests made under these conditions would be very important, every precaution should be taken to make them accurate, that no favor or injury might be done.

W. M. Wood:—In the testing of gas appliances the actual efficiency as determined by any form of calorimeter such as suggested by the Committee of the Ohio Gas Light Association of 1903, is one of the minor considerations both to the consumer and also to the gas company. It is to the advantage of the gas company to keep the gas appliances of their consumers in good order to make it both convenient and economical to the consumer to use them; the convenience being the more important of the two. An efficiency between 50 per cent. and 75 per cent., unless the consumer actually knows what it is, will not be considered.

In the case of the ordinary gas range, which usually constitutes over 75 per cent. of the appliances in any town, there are several very essential points to be considered in the choice of the various makes to be handled by the company. Among these are:

1. Removable burners to facilitate cleaning.
2. Snugly fitting air shutters, convenient to adjust.
3. Removable linings to facilitate repairing.
4. Sufficient weight in casting to prevent breakage in moving.
5. Good distribution of heat in oven to bake properly.
6. Properly set burners, to prevent incomplete combustion under hot pan, giving bad odor.
7. Oven burners set low enough so the flame does not impign upon the heat distributor or oven bottom.
8. Sufficient flue opening to prevent smothering of the burners.
9. Linings of sufficient thickness, 22 or 24 gauge Brown & Sharpe, to prevent rusting out in a reasonable time.
10. Proper construction of top burners, to prevent leakage at cemented joints.

In handling from 400 to 500 complaints per week on gas ranges alone in Philadelphia, I find the improper construction is a much more important point than low efficiency.

In the case of circulating and instantaneous water heaters, the efficiency is an important factor, but a heater with a high efficiency and a very short life, sometimes not lasting over four months before needing extensive repairs, is not one to be desired, and there are such on the market.

These are only a few suggestions as to the character of the work which your proposed committee will find most beneficial to the gas companies of your Association.

F. W. Stone:—It seems to me that it is desirable that the Ohio Association appoint such a committee for the following reasons:

Very few gas managers would be able to obtain all of the gas appliances, and test them for the purpose of ascertaining which is the best. Very few gas managers have time to do this even if they could obtain the appliances on which to make the test. Also, a large number of our managers do not have all of the apparatus necessary for properly conducting the experiments. If the experiments were conducted by a committee, the appliances could be tested under absolutely uniform conditions, and it would be possible for them to obtain a larger number of samples to make the test on.

E. M. OSBOURNE:—Yes.

B. C. COBB:—Yes.

No. 216. What are the best indirect gas-heating arrangements for use in residences in mild weather, taking the place of a coal furnace?

ALTON LIGHT & TRACTION CO.:—This company is now experimenting with Eclipse heaters attached to hot water plants for use in mild weather.

S. TULLY WILLSON:—There is a gas heater made to be placed in the hot-air pipe under the register, which may have merit. However, a good gas grate is preferable.

No. 217. What is the best plan to utilize gas in a coal hot-air furnace or boiler in mild weather?

S. TULLY WILLSON:—Where a hot water system is used, a circulating water heater, or several of them if greater capacity is required, may be connected in parallel with the coal heater, and the latter cut out by valves in mild weather and the gas heaters used. This is very satisfactory if properly installed.

No. 218. What success has been attained by gas hot-air furnaces or boilers for residence heating?

J. J. KNIGHT:—Artificial gas of about 600 heat units is worth about 30c per thousand cubic feet for use in hot air furnaces in competition with anthracite coal at $7.00 per ton. It is worth more than that price in connection with hot water heating, but as not many companies can afford to sell gas at this price it is not used to any extent.

H. G. OWENS:—We have installed, in hot water and hot air furnaces, thirty-five burners, and for the month of January the average consumption per day was 42½c worth of natural gas at 20c per thousand. We find but little difference in the consumption of gas between hot water and hot air furnaces. The cost with but few exceptions has been satisfactory, and a great many more furnaces will be equipped during the coming season. The Vulcan Sectional Furnace Burner has given us the best satisfaction.

EDITOR:—The use of hot-air furnaces and boilers for residence heating cannot be made as economical as a separate gas heater in each room, and economy is such an important matter when the fuel is so expensive that it would seem advisable to induce the prospective consumer to use an independent heater in each room.

No. 219. Is there any successful method of preventing alkaline deposits in independent water heaters, without decreasing the efficiency of the heater?

H. S. HUMPHREY:—Hard water used for steam or in a circulating water heater, will deposit lime. It will not deposit lime, however, to amount to anything until the temperature of the water is raised to about 200 degrees F., as it is in a circulating water heater. At the boiling point it deposits more rapidly.

In an instantaneous water heater the water is not heated above 140 to 150 degrees, and lime is not deposited.

An automatic instantaneous water heater burning gas is a splendid device. It does not boil the water and lime is not deposited, but it is quite expensive to manufacture.

ORAL DISCUSSION.

MR. DOHERTY:—That was the only response I received to that question, and I would disagree with Mr. Humphrey in his statement that water in a circulating heater is raised to a temperature of 200 degrees Fahr.

MR. OSBOURNE:—I would like to ask if any of the members have had any trouble with any other deposits in their circulating heaters?

MR. DONALD McDONALD, Louisville, Ky.:—One good turn deserves another, and I will say for my friend Doherty's benefit that I have opened the stop cock where a circulating water heater was used and have drawn steam for two minutes.

MR. DOHERTY:—That heater was probably put up in one of Mr. McDonald's original ways. The water heaters now on the market do not raise the temperature of the water to exceed 50 degrees, and it is simply a question of the freedom of circulation through the water heaters. If your heater is set low and it has free connections you may not get a rise in temperature of over 20 degrees. That is, the water will circulate so rapidly through it that the heat from the gas will not increase in temperature more than 20 degrees.

No. 220. Do the majority of the domestic users of water heaters prefer them to be of large or small capacity?

H. S. HUMPHREY:—Large. Instantaneous water heaters to be of value should have a capacity to heat 2 gallons of water per minute, raising the temperature of the water 50 degrees above the initial.

C. F. TERHUNE:—The question of larger or smaller capacity is governed somewhat by what the ideas of various men may be as to large and small capacity. Our No. 9 Vulcan water heater consumes from 30 to 35 feet per hour under 2-inch pressure. We find that this heater can raise the temperature of the water from starting point 59 degrees at the rate of one foot of gas to one gallon of water. That means that we can heat the ordinary 30-gallon tank, such as is commonly used, in one hour's time, that sufficient water can be heated for dish washing in ten minutes, and for the bath in 20 minutes. For the larger size boilers, from 60 to 80 and 100 gallons, we would recommend our larger heater, the No. 10, consuming from 45 to 60 feet of gas, which would heat a like amount of water in proportion. Our customers throughout the U. S. (and we practically cover the country) consider the heater using from 30 to 35 feet of gas sufficient for all household purposes, except in the rare cases where very large boilers are used.

J. H. HAGERTY:—The majority of the domestic users of water heaters prefer them large enough to do the work required rapidly.

W. V. SPINNING:—Large.

No. 221. Do most people prefer to keep water in the kitchen boiler hot all the time?

C. F. TERHUNE:—We only know of one or two cities who advocate the delivery of a small quantity of hot water from the top of the boiler rather than the heating of the whole boiler. We have always sought in our appliances to get perfect circulation, which means that the water in the whole boiler is heated to a given temperature from top to bottom. We do not advocate keeping the boiler hot all the time, but running the heater one hour which will insure a full boiler of hot water, and when that is exhausted and more wanted, would light it again. One of the strongest reasons for not keeping the boiler hot all the time is that even in summer time it requires 7 feet of gas per hour to keep water up to an average temperature of 120 degrees to overcome radiation on a 30-gallon boiler. This is in excess of amount of gas needed to heat water as used. On the basis of ten hours a day for thirty days, this would consume 2,100 feet of gas, which is as much as the ordinary house-holder ought to consume for his total wants for hot water.

H. S. HUMPHREY:—Yes, the objections are the expense and overheating the kitchen at certain seasons. The instantaneous water heater overcomes both of these and is always ready and supplies hot water instantly, etc.

W. C. HUGHEY:—Most consumers want hot water in the boiler at all times. While it has been demonstrated to them that for small quantities of hot water it is cheaper to use range top burners, they can't get out of the habit of going to the hot water faucet, as with a coal range it is always hot.

J. H. HAGERTY:—No.

PHILO JONES:—Our experience indicates that a chief objection to the gas water heater is that water cannot be had without three or four minutes delay, unless the expense of a constant fire is undergone. Perhaps a solution of the question can be found in the "thermostatic" valve which has been put on the market.

W. V. SPINNING:—Yes.

No. 222. In a residence of say ten rooms with a forty gallon boiler, five in family, what capacity heater in gas consumption should be recommended?

H. S. HUMPHREY:—A circulating water heater in such a residence should raise the temperature of 40 gallons of water 50 degrees in 30 minutes, and will use about 1,000 cubic feet of gas per hour.

An instantaneous water heater should heat at least 2½ gallons of water per minute, raising the temperature 50 degrees in 30 minutes, and will use about 100 cubic feet of gas per hour.

An automatic instantaneous water heater for such a residence should heat from four to five gallons per minute and use about 240 cubic feet per hour.

In circulating water heaters one cubic foot of gas will raise the temperature of one gallon of water about 45 degrees.

In instantaneous heaters one cubic foot of gas will raise the temperature of one gallon of water 60 degrees.

C. F. TERHUNE:—For a house of ten rooms we should say that a heater consuming from 30 to 35 feet of gas should supply the wants, except possibly on Monday, when the greater quantity of water is used for the weekly washing.

J. H. HAGERTY:—Sixty to seventy-five feet per hour.

F. TOBEY, JR.:—About 40 cubic feet per hour.

W. V. SPINNING:—Twenty-five cubic feet.

No. 223. What is the proportion of air usually mixed with the gas in the mixers of gas appliances?

C. F. TERHUNE:—About 75 per cent. of air and 25 per cent. of gas.

J. J. KNIGHT:—From 2 to 2½ times the volume of gas used.

No. 224. Where is the proper place for a simmering burner on a gas range?

C. F. TERHUNE:—We have tried simmering burners on different parts of the range and after consulting with our largest buyers throughout the country, we find that the most satisfactory place for the simmering burner is at the extreme right hand side of the range between the front and back burner. Having the simmering burner placed here enables one to use the side shelf as a resting place for the utensils.

W. C. HUGHEY:—Simmering burner should be in the center of giant burner, which should be the right hand rear burner.

HENRY S. WHIPPLE:—At one end of the top, so that it will not interfere with the use of any other burners.

W. V. SPINNING:—In the center.

No. 225. Is the luminous or blue flame preferable in gas room-heaters, and why?

C. F. TERHUNE:—By all means the luminous flame, for the reason that if a proper burner is used we get very nearly perfect combustion, whereas the blue flame, unless properly adjusted, is apt to liberate gases detrimental to health. We do not claim that the air-mixed flame cannot be used, but the ordinary householder, in fact the ordinary handler of gas appliances, is not sufficiently expert to adjust the Bunsen flame to the proper point.

W. C. HUGHEY:—Luminous flame is preferable on account of cheerfulness and is ordinarily odorless. There is no popping back in the mixer, which is a great annoyance.

WALTER M. BLINKS:—There is absolutely no difference in amount of heat given off per foot of gas consumed whether burnt in illuminating or atmospheric burner, provided combustion is complete. The luminous flame is bright and cheerful in appearance, as is also the asbestos back of some blue flame heaters, but it is more difficult to insure proper combustion in the latter. Were it not for erroneous popular impression that the blue flame consumes less gas for given amount of heat, the luminous flame is to be preferred in small flueless heaters, but life is too short to argue with our patrons, so it is best to keep both styles in stock and sell what is wanted.

No. 226. Should flues be used on gas ranges?

C. F. TERHUNE:—In New York City, probably 75 per cent. of the ranges are put up without flue connection. Where ranges are installed in apartment houses or flats and are used for total wants for cooking, both winter and summer, they are invariably connected with flue, but where in private homes and used in the summer only, we rarely make flue connections, as the kitchen is generally well ventilated.

J. J. KNIGHT:—Gas ranges used all the year should certainly be connected with a flue. For use in the summer kitchen only, not necessary.

PHILO JONES:—Yes, but inasmuch as the flue connects only with the oven, a steam hood should also be used. The atmosphere in a kitchen using a gas range is moister than the same kitchen is when using coal or wood range. We contemplate experimenting with hood to determine if it is possible to obviate this difficulty.

W. V. SPINNING:—No, unless the gas is poor or dirty.

No. 227. Why do the ovens of some ranges sweat so much more than others of the same make of range?

J. H. HAGERTY:—Excess of moisture in some range ovens is probably due to insufficient ventilation.

J. J. KNIGHT:—They do not, under the same conditions of temperature, etc., and the same gas.

No. 228. What make of gas-heated bakers' ovens has given the best satisfaction?

J. J. KNIGHT:—The Eclipse Gas Stove Company makes the best one I know of.

No. 229. Approximately, how much gas would be required per day of eight hours to keep five to eight hundred pounds of stereotype metal melted under the usual operating conditions?

C. F. Terhune:—Assuming the burner has a reasonably high efficiency, say 66 per cent., it would require 75 feet of gas per hour to keep the stereotype metal up to the point of usual operating conditions, or 600 feet for the eight consecutive hours.

No. 230. What occasions the disagreeable odors from some water heaters when first lighted, and why?

James Ferrier:—The cause is incomplete combustion of the gas, resulting from the flame being chilled. This is more especially the case when the inner cone of a Bunsen burner impinges on a cooling surface.

The writer has found, however, that even where the flame is not in actual contact, the chilling of the products of combustion above the burner produces the same result, although probably to a less extent. It is probable that the products of combustion become heavier than the atmosphere and fall back upon the burner, thereby interfering with combustion. The prompt removal of the products of combustion is a very important factor in securing the proper conditions for burning gas.

The effect of the impact of a Bunsen flame on a cold surface, as regards production of carbon monoxide, was the subject of a special investigation by Dr. Thorpe, of London, last year. He found that gas, burning under such conditions at the rate of 6 feet per hour, produces in that time 0.022 feet of carbon monoxide.

C. F. Terhune:—The particular reason for the disagreeable odor in some water heaters when first lighted is that the amount of space for combustion is too small. To illustrate this, with our water heater up to 35 feet of gas, same gives off no odor, but with 40 feet of gas we get a strong odor and do less work with 40 feet of gas than we can with 30 in the way of efficiency.

H. S. Humphrey:—A large volume of gas burning in an enclosed space impinging slightly on cold metal will produce odor from sharp condensation of the products of combustion, which is somewhat imperfect at first.

All water heaters should be connected with a flue, and as all flues do not work exactly alike different results in this respect will appear, but with a flue connection, if the heater is properly constructed, the odor will cease in a moment or two after lighting the gas.

Walter M. Blinks:—When a flame impinges on a cold surface, the flame temperature is lowered and unconsumed gases are given off. In a water heater cold water circulates through the coils and for some minutes after lighting the burners the gas is continuously chilled and incomplete combustion occurs at point of contact. Aside from above reason it seems impossible in present designs of water heaters to avoid some smothering of flame without the assistance of a flue in giving draft, and we doubt if a more simple expedient will be devised in the near future.

No. 231. Would the public not prefer larger burners on the tops of their gas ranges?

C. F. Terhune:—Have not found that the public call for more than one large double burner in connection with three of smaller size on ranges as generally sold.

W. C. Hughey:—In Denver, there have been several requests made to have giant burner removed from range.

Walter M. Blinks:—Do not think it at all necessary. The majority of gas range operators go on the theory of "full speed ahead" and open the burners wide whether needed or not; given a larger burner, more gas will be consumed in unnecessary evaporation of water, or other waste.

J. H. Hagerty:—The burners that are now supplied on the tops of gas ranges seem to fulfill all requirement.

Philo Jones:—We have frequent calls for the double ring burner, operated with a valve for each ring. A double ring or extra strength burner with one valve would not be desirable.

No. 232. Of what advantage are ventilated chimneys having holes in the bottom for the admission of air? In connection with the use of incandescent mantles, does the admission of air prevent the chimneys from breaking, or add to the intensity of the flame temperature?

J. J. Knight:—Ventilated chimneys made the same size and of the same quality of glass will break just as often as any other chimney. Most chimneys of this character are larger than the ordinary chimney. Their principal advantage is the strong draft which they create, which serves to aerate the flame at the surface of the mantle, preventing its burning through the mantle, and also serves to lift the flame higher in the mantle.

The style of chimney will not soil as quickly as the ordinary chimney. Burners using this style of chimney, when at their best, are large consumers of gas, and the light is somewhat unsteady, being affected by any change in the air current surrounding them. It is somewhat difficult to maintain a pilot or by-pass on them.

No. 233. Are the long incandescent mantles which are now in use of any advantage, considering the fact that the mantles break more quickly than the smaller size, and considering that the rod which supports them burns and breaks?

W. C. Hughey:—While the consumer receives more light when using a long incandescent mantle than when using a short one, the increase of light is not proportionate to the increase of gas consumption. The cost of maintenance is also higher.

J. J. Knight:—They are not. With the same amount of gas they will not develop as much light as the ordinary mantle, and as stated they break more readily, and with the large consumption of gas no metal support will stand the high temperature.

F. Tobey, Jr.:—In our experience, no.

Philo Jones:—Customers demand light, and all they can get. It is up to the mantle manufacturer to give us a mantle which will meet the new conditions.

No. 234. Why will a gas engine develop more power with gasoline than with gas?

J. H. Hagerty:—The increase of power in a gasoline over a gas engine of the same size is due to the greater expansive properties of gasoline.

Editor:—The capacity of a given volume of cylinder contents will vary about in proportion to the calorific value of a unit volume of the explosive mixture, and as a cubic foot of explosive mixture of gasoline has a higher calorific value than an explosive mixture of gas, the capacity of the cylinder is increased by the use of gasoline. The capacity of a gas or gasoline engine is considerably diminished if used in high altitudes. The atmosphere being less dense, the cylinder is supplied with less oxygen for the combustion of the fuel at each stroke. It is necessary in Denver to either compress the gas or air before it is supplied to the engine, or else reduce the clearance in the cylinder.

NEW BUSINESS MATTERS.

No. 251. Can the waste heat from coal gas benches be utilized to establish a district heating plant?

H. H. Powell:—The average works would, I think, find it more desirable to build, supply and operate a natatorium, using the surplus heat for this purpose rather than for district heating.

W. E. Brown:—Not if most of the waste heat is used up for heating secondary air as it should be.

Alton Light & Traction Co.:—From this company's experience with district heating, it would hardly undertake to utilize the waste heat of its coal gas benches for district purposes.

Frank N. Davis:—See answer to question No. 67.

LEGAL AND FINANCIAL MATTERS.

No. 301. What method should gas companies advocate as a basis for taxation which would equitably divide the burdens of taxation between them and other taxpaying corporations and partnerships? It has been customary in some states to tax gas companies on the value of their outstanding securities.

Paul Doty:—The General Law for Michigan says: "The Supervisor (or Assessor) shall estimate, according to his best information and judgment, the true cash value of every parcel of real (and also personal) property, and set the same down opposite such parcel."

Another section recites: "The words, 'cash value,' shall be held to mean the usual selling price at the place where the property to which the term is applied shall be at the time of assessment, being the price which could be obtained therefor at private sale and not at forced or auction sale. In determining the value, the assessor shall also consider the advantages and disadvantages of location;" and it may be added, all other element which go to make value. Location and earning capacity give value to the franchises, and while franchises as franchises are not specifically taxed, earning capacity, location, management and everything else which gives or reflects value to the bonds and stocks of the companies add to the "true cash value."

A prominent banking house in New York investing largely in gas securities lays down the following rules in the purchase of gas and other properties:

1. To investigate the actual and intrinsic value of the real and personal property and the regularity of title covering same.
2. The character, scope and legality of the franchise.
3. The earning capacity of the plant.

It would seem that to follow these rules would be a fair way of determining the "true cash value."

J. J. KNIGHT:—Gas companies should try to get their assessed valuation based on their sales of gas. They are taxed now most inequitably, both as compared with other manufacturing concerns and as compared with one another. Organized effort, intelligently applied, would doubtless result in Assessors, Boards of Review, and State Tax Commissions being willing to adopt some fair uniform system of taxation.

I made some little effort in this direction in Michigan some time ago, but found I could not obtain the co-operation of all the gas companies, as some of them preferred not to have existing conditions disturbed. A State Gas Commission would be serviceable in this particular. Gas bonds in Michigan are taxable when found.

F. W. STONE:—I have often thought that gas companies, or in fact all public service corporations, ought to be taxed on the amount of business they do, instead of their investment. For instance, a gas company has an investment of $100,000, and on this investment does a business of $25,000 a year. A merchant might only have a capital of $25,000, and do a business of $50,000 a year. If this example is anywhere near correct, a much greater proportion of the gross earnings of the gas company will go for taxes than those of the other corporations, and the consequence is they will have to have a higher percentage of profit on the sales. It is this fact that makes our consumers think that there is a larger profit in the business than there actually is.

RESIDUALS.

No. 351. How can olefiant gas (C_2H_4) be manufactured from coal gas? A manufacturer says that this gas can be sold for 25c per pound if it can be manufactured in a pure state.

No. 352. What value has aqua ammonia as a fertilizing agent, and what precautions must be observed in its application?

Donald Davidson:—Aqua ammonia is not suitable, as ammonia evaporates and is lost. Ammonia as fertilizer is always used in form of sulphate.

Editor:—Some years ago I experimented upon a potted geranium and a small amount of sod, using very dilute aqua ammonia as a fertilizer. I made no attempt to determine what results were obtained with a given quantity of ammonia, but the effect on the plant and grass was quite noticeable and they seemed to respond more quickly to this treatment than by the use of other fertilizing agents.

No. 353. What is the best practice for removing cyanogen from the gas?

Howard E. Mann:—Mechanical washing with ferrous hydrate solution.

Clarence S. Lomax:—The best practice for the removal of cyanogen from coal gas is that of Dr. Knubloch or Dr. Bueb; full accounts of these and discussions on the same can be found in the *Journal of Gas Lighting*, or the *Journal fur Gasbeleuchtung* during the past year.

W. B. Calkins:—Mr. Wm. Faulis, the gas engineer for the Glasgow Corporation, has a patent method for removing cyanogen from coal gas, which has been put to practical use. The coal gas containing cyanogen, after passing through the ammonia scrubbers, is run into a Holmes washer-scrubber containing a mixture of ferrous carbonate and sodium carbonate. This is kept well stirred, the hydrocyanic acid in the gas combining with the mixture to form ferrocyanide of soda, which is drawn off from the last partition of the scrubber as fast as produced.

No. 354. Has anybody found a market for their coke breeze for filtering purposes?

No. 355. What is the best alkali agent considering economy for freeing fixed ammonia?

GEORGE OSIUS:—The only alkali agent considered practicable and commercially economical is lime. Soda and magnesia can also be used. The former is too expensive; the latter forms insoluble basic salts and does not entirely liberate the NH_3.

DONALD DAVIDSON:—Lime.

R. H. SEARS:—Lime.

CLARENCE S. LOMAX:—The best alkali reagent (considering economy alone) for freeing fixed ammonia is a lime containing as high a percentage of magnesia as is obtainable without increase of price over ordinary lime.

W. M. SITES:—Reference: *American Gas Light Journal*, Feb. 3rd, 1902, page 150.

No. 356. In distilling ammonia, what per cent. of it can be recovered from the crude liquor where no alkali is used to free the fixed ammonia, and what per cent. where some freeing agent is used?

HOWARD E MANN:—The following distillations of ammonical liquor gave per cent. free NH_3 as follows:

Free NH_3,	Fixed NH_3.	Total Per Cent.
1.78%	.28%	2.06%
1.84%	.22%	2.06%
1.83%	.24%	2.07%

Potassium hydrate solution was used to free the fixed NH_3.

GEORGE OSIUS:—When no lime is used eighty to ninety per cent. of the entire ammonia can be liberated. When lime is used over ninety-nine per cent. can be obtained.

CLARENCE S. LOMAX:—This percentage will vary according to the coal used. With most American coals the per cent. of ammonia recovered without alkali would be between eighty-five and ninety-five per cent. With our coal (Capt Breton coal) only sixty-six per cent. is recovered without the use of lime.

DONALD DAVIDSON:—Varies greatly. Best found by experiment in each case.

W. E. HARTMAN:—This depends upon the quality of the coal, the temperature of carbonization and the treatment of the liquor in scrubbing, etc. The proportion of fixed ammonia, or that part whose recovery requires the use of a freeing agent, can be determind by a chemical analysis of the crude liquor produced under any given conditions.

JOHN S. UNGER:—The usual amount of ammonia found as fixed salts in crude liquor from Pittsburg coal in gas works is one-fifth of the total ammonia present in the liquor. A good still will have ninety-nine per cent. efficiency, so very little ammonia is lost through distillation; consequently four-fifths, as a rule, of all the ammonia will be recovered in a still working with no freeing agent for the fixed ammonia, and practically all ammonia is recovered when a freeing agent, such as slaked lime, is used.

No. 357. Has water gas tar been successfully used for metal melting?

No. 358. What type of coke crusher produces the least breeze?

EDITOR:—I cannot say what coke crusher produces the least breeze, but I consider this a pertinent question and am sorry no one has tried to answer it. Although not directly answering the question, it might be suggested that by screening the coke and passing only that portion of the coke of a size in excess of the size wanted through the crusher, less breeze would be made than by passing all coke through the crusher. Screening on a proper revolving or shaking screen does not cause much breakage or crushing of the coke.

No. 359. What is a reasonable differential between the price of genuine gas coke and anthracite coal?

F. W. BLOWERS:—Twenty-five per cent. less than price of hard coal.

J. J. KNIGHT:—Convenience, cleanliness and efficiency considered, it is not less than $1.50 per ton, and my experience is that at about this difference coke sells readily.

HENRY S. WHIPPLE:—The experience here (Rockford, Ill.) makes it $3.50 per ton.

FRED H. BECK:—Here (Aberdeen, S. D.) the difference is $2.25.

ALONZO P. EWING:—I believe this question is of the greatest importance to every gas company having coke for sale. There is no argument that has been brought to bear, as yet, upon my mind to convince me that there is any reasonable difference between genuine gas coke and anthracite coal. Isn't it reasonable and also possible that the time will come when anthracite coal must be replaced to the extent of the make of coke? The enormous increase in outputs that has been recorded during the year 1903 has made the proportional increase in the amount of coke. In the state of Michigan, through recent correspondence, I find that all companies have a greater stock of coke to-day than is usual for this time of the year. This is partly on account of the enormous amount of anthracite coal that was rushed into the state last summer, and partly on account of the enormous increase in the coke production. With systematic work I see no reason why, within a reasonable length of time, coke should not sell for within 50 cents of the price of coal—not that it is not worth just as much as coal, but the feeling of the American public to-day is a willingness to pay a little bit more for something that makes less work.

Until such concerns as the American Radiator Company can install a number of special coke furnaces, so that coke, as a fuel, will be as convenient to us as coal, just so long must it be lower in price than hard coal.

Those who have given coke a sufficient trial in their furnaces to-day are loth to go back to hard coal, because the results are so very different, and they can appreciate the quick results that can be obtained from coke.

Through intelligent care of the furnace, it has been proven that there is no damage to grate bars. This is also true when coke is used in the base-burner. It has been said that there may possibly be a reduction another year in the price of anthracite coal, but as the anthracite prices are under absolute control, we see no reason for cutting the price. It surely could not make a greater demand for their fuel.

Every gas company that has a large amount of coke to dispose of must dispose of it as fuel. Is there anything more essential than to so thoroughly advertise and prove to the public the efficiency of this kind of fuel as to obtain a good price for coke and increase the net earnings?

DONALD DAVIDSON:—About 30 per cent. here (Detroit). We have Semet-Solvay coke to compete with.

No. 360. If the number of heat units of genuine gas coke is in excess of the number of heat units in hard coal, as was found by an actual test in the laboratory in Ann Arbor, is not genuine gas coke worth as much as anthracite coal in dollars and cents per ton?

J. J. KNIGHT:—It does not seem possible to utilize the theoretical heat value of coke in our present heating appliances, or in other words, to maintain a large body of fuel at a low temperature, which is the economical way to use any fuel.

CLARENCE S. LOMAX:—If the number of heat units of gas coke is in excess of the number of heat units in hard coal, it is worth more than the hard coal for any purpose except where the fire is not, or cannot be, carefully regulated. As this is not possible in most domestic uses, the coal assumes a higher value on account of its denser structure and consequently smaller waste from careless use.

DONALD DAVIDSON:—Heat value of coke may be greater, but other things must enter into the determination of value, especially for domestic use. Coke has some disadvantages. It is bulkier, does not fed so well in magazine stoves, and is apt to form clinkers and burn out linings of stoves. Coke usually contains more water than coal. The smaller the size of coke the more likely it is to form clinker and burn out stoves.

HENRY S. WHIPPLE:—People believe that coke burns more quickly than hard coal does and therefore is not worth so much as coal, hence the differential price.

J. H. ENRIGHT:—No, because we have failed so far to procure a stove that will handle the heat from coke as economically as it is handled by a hard coal range.

W. E. BROWN:—Not necessarily. Coke will give more trouble by clinkering and is much harder on stoves than anthracite coal.

No. 361. How can we recover cyanogen in the form of a simple compound of an alkaline base, uncontaminated with thiocyanate?

HOWARD E. MANN:—By extracting the cyanide from the original residuum as an alkaline salt, then precipitating the ferro cyanide from an acid solution with a ferro ferric sulphate solution; filtering off the blue formed, washing to eliminate the balance of the thiocyanates and other compounds and then decomposing this with alkaline carbonates, filtering off the insoluable iron salt formed, and the solution will contain the ferro cyanide salt of the base used, which can be obtained by evaporating to the crystallizing point.

W. M. SITES:—Reference: *American Gas Light Journal*, July 21st, 1902, page 77.

No. 362. Why does concentrated ammonia liquor vary without apparent cause from dark reddish brown to pale greenish yellow?

HENRY I. LEA:—These changes are caused largely by the varying proportions of carbonates and sulphides. Carbonates produce the lighter colors, and the sulphides the darker.

No. 363. What are the conditions under which phenols occasionally appear in abundance in the waste from an ammonia concentrator?

HENRY I. LEA:—I should say that the presence of phenols in the waste from the ammonia concentrator, is due solely to the improper working of the coal tar separator.

No. 364. Is there any serious objection to using a hydrometer as an indication of the strength of ammonia liquor?

HOWARD E. MANN:—The distillation test for total ammonia is the only correct way to determine the strength of ammonia liquor.

F. TOBEY, JR.:—Use it, but do not rely too implicitly upon it. It is liable to indicate high.

GEORGE OSIUS:—The use of a hydrometer as an indicator of the strength of crude ammonia is undesirable, as the readings will change with varying quantities of different salts in the liquor even though the same total NH_3 is present. Moreover the possible presence of free ammonia will lower the reading of the instrument instead of raising it. This applies equally to concentrated liquor.

HENRY I. LEA:—There is no serious objection to the use of a hydrometer as an indicator of the strength of ammoniacal liquor where only approximate results are required. It could not, however, be relied upon for exact determinations, as the quantity of ammonia present is not necessarily dependent upon the specific gravity of the liquor.

No. 365. What industries make use of crude ammonia liquor in small quantities?

No. 366. Is there any satisfactory method of freeing crude ammonia liquor of suspended tar other than long settling in large wells?

GEORGE OSIUS:—I have frequently recommended the following for the purpose of securing clear liquor and at the same time saving the light tar:

Construct a wooden partition from bottom up within about 18 inches from the top, bring down an independent partition from the cover of the tank extending about three to four inches beyond the top of the lower partition, leaving about two inches space between the partitions. Lead tar and ammoniacal liquor into that side of tank in which the upper partition is placed. The heavy tar will settle almost immediately; the light or floating tar and oils will be retained by the overlapping partition and will gradually settle. This construction will permit the collection of perfectly clear liquor in the other part of the tank from which it can be used for washing or concentrating purposes. The partition can be made of two or three-inch planks which should be tight, but it is inexpensive and very effective where no mechanical tar separators are used. The capacity for each partition can be arranged at will and depends upon the necessary storage capacity for tar and liquor at disposal.

E. J. CURLEY:—Our tar and ammoniacal liquor are in the same well, but we use a floating suction when pumping liquor to the still of the concentrating apparatus, and are thus relieved of any tarry matter.

G. FALKENSTEIN:—In Erie, Pa., we had one tar well and one ammonia liquor well, the tar well receiving all the tar and liquor

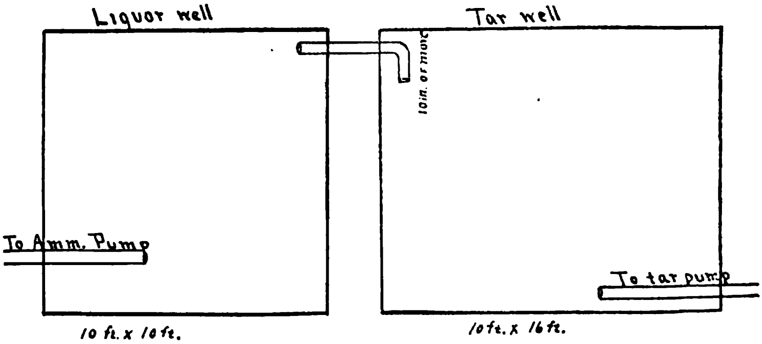


FIG. XI.

made from the works. The overflow from the tar well was connected to the ammonia liquor well, as shown in sketch. We had no trouble from tar held in suspension in the liquor. In this way we used the ammonia liquor from 22 benches of 6's (H. P. Watson Co.), without settling, for making aqua ammonia.

No. 367. Why cannot concentrated ammonia liquor from a continuous concentrator be safely shipped at as high a strength as the product of an old-fashioned intermittent still?

H. B. HARROP:—It is a fact that ammonia liquor from a continuous concentrator, if too highly concentrated, will "salt out" in the tank cars in cold weather, while liquor made in an old boiler with the co-operation of a steam coil and a charge of alkali will be free from this danger in a large measure. The explanation lies in the more efficient working of the continuous concentrator with reference to the amount of alkali used, in this case being restricted almost entirely to action on the fixed salts, allowing the carbonic acid to go over with the ammonia into the storage tank. In the old style still where the alkali is dumped in with the charge, the finished concentrated liquor contains relatively little carbonates

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No. 368. When a pitch is produced from a mixture of coal tar and water gas tar, why does not the lamp-black in the water gas tar increase the free carbon in the pitch in proportion to the percentage of water gas tar used?

No. 369. It is easy to render heavy oil (dead oil) of tar "soluble" or emulsifiable with alkali and rosin. Newbigging speaks of accomplishing the same end with alkali and tallow. Is there such a formula?

W. B. CALKINS:—Heavy oil of tar, if free from phenols (which cause friction), can be used as a lubricant by mixing with it dry slaked lime and rosin oil. The formula for same can be found in Lunge's "Coal Tar and Ammonia," page 443.

No. 370. Should not gas companies advocate the use of screenings where customers say that coke requires too much attention to the furnace, and, would it not mitigate the gas man's horror of the crusher because of the extended market he would have for his screenings?

J. J. KNIGHT:—Yes, sir.

WALTER M. BLINKS:—A judicious mixture of fine coke, not dust, with the larger sizes makes a better furnace fuel and a little educational work will soon establish the fact and help coke sales.

F. W. BLOWERS:—The best coke for furnace use is the "mixed coke"—all sizes—as it comes from the retorts, minus what breeze can be taken out when loading with a fork.

J. H. ENRIGHT:—Yes, I have found it an excellent idea to have coke consumers use screenings for banking, where coke is used in furnaces.

No. 371. What is the minimum output of gas works necessary to make the saving of ammonia profitable?

GEORGE OSIUS:—A minimum carbonization of say 1,500 tons of coal per annum will, with proper care, produce about 6,000 pounds of ammonia, and this production is considered large enough to make the saving and concentration of ammoniacal liquor a profitable investment.

E. J. CURLEY:—On a carbonization of, say 12,000 tons, a return of from seven to nine per cent.

A. F. REITMEYER:—Twenty million cubic feet per annum; figuring to receive four pounds of ammoniacal liquor to a ton of coal carbonized. Receipts for ammonia would be approximately $550.00 per year. Cost of installing plant, $2,500.00.

No. 372. Do you sell the carbon from the retorts, and if so, at what price and where do you find a market for same?

E. J. CURLEY:—Have received in 1902 $9.00 per ton of 2,000 pounds, f. o. b. Wilmington, Del.

A. F. REITMEYER:—Yes; $16.00 per ton f. o. b. works. Eastern Carbon Company, Jersey City, N. J. Lewis Hazlett, West Virginia.

JOHN J. POWER:—We sell all the carbon we can make at a price of $10 to $11 per ton, f. o. b. our city (Cumberland, Md.). Many of the electrical manufacturing companies, as well as the makers of arc light carbons and brushes, are purchasers of retort-house carbon.

F. W. STONE:—We have always sold carbon from our retorts, finding a market for the same with the manufacturers of electric light carbons. The price has ranged from $6.00 to $14.00 per ton.

HARRY BLANCHARD:—Mr. Edward Hazlett, of Wheeling, W.

Va., pays us $9.00 per ton, f. o. b. our works (Mendota, Ill.), for carbon from our retorts.

ALEX WYNESS, JR.:—Yes; $10.00 per ton. Any carbon manufacturers are glad to purchase same.

No. 373. Can lamp-black be secured in paying quantities at a gas plant, and how?

H. B. HARROP:—Reference: Lunge's "Coal Tar and Ammonia," chapter IV, last paragraph.

No. 374. If coal tar is worth 2.5c net per gallon f. o. b. plant, would it pay to use it for fuel either in boilers or under the benches?

WALTER M. BLINKS:—At the 1902 meeting of the American Gas Light Association Mr. C. F. Pritchard read a carefully prepared paper on "The Fuel Value of Residuals." This gives valuable data concerning a number of questions asked this year, and should be read by those interested.

In average running of boilers one pound of bituminous coal was found to evaporate 9.8 lbs. of water. Coal tar, which is stated to burn perfectly with device fully described, evaporated 11.91 lbs. water per pound of tar. It is now a simple matter of proportion.

9.8 : 11.91 : : Cost coal: value of tar for fuel.

Substituting price at which good bituminous coal could be purchased in Boston, namely, $3.75 per ton,

9.8 : 11 :91 : : $3.75 : value tar (or $4.55 per ton).

Weight 50 gallons tar, 516 lbs.

Value 50 gallons tar, $1.17.

The author thought an evaporation of 14 lbs. water to a pound of tar might be obtained under better conditions, giving a fuel value of $2.76 per gallon of tar, as against good coal at $3.75 per ton.

J. H. ENRIGHT:—No, unless you are securing very fancy prices for your output of coke.

ALEX. WYNESS, JR.:—Do not think it would.

No. 375. Has anyone experimented with washing or blowing coke to eliminate the excessive quantity of dust (as compared with hard coal) consequent upon its use, and if so, with what results?

MANAGEMENT.

No. 401. What is the best time in the year for gas men to leave their plants to attend a convention?

E. J. CURLEY:—September.

IRVIN BUTTERWORTH:—In the early spring.

M. T. WALKER:—October.

E. M. OSBOURNE:—August.

W. A. ALDRICH:—The proceedings of an association meeting are of such vital interest to its members and benefit to the respective companies, that nothing short of a calamity should be allowed to prevent a member from attending at any time during the year. A gas company must be in a poor shape that will not allow someone to attend, and least of all gives such a flimsy excuse as the date being inopportune.

ORAL DISCUSSION.

MR. DOHERTY:—That is something we ought all to have views upon, Mr. President.

PRESIDENT MCILHENNY:—It is certainly a very timely subject.

MR. STONE:—Speaking personally, if we could control the weather man almost any time of the year would suit me. But I do not feel as though I ought to leave the plant with which I am connected in cold weather when we are having difficulties by reason of frost and that sort of thing. Heretofore March has been a month that was all right because it came just immediately after the cold weather and before we really had begun our spring work. This year, however, I do not know whether it was because the winter has been longer or what reason, it has been hard for the gas manager to get away in order to attend the convention. I felt that there were responsibilities devolving upon me which ought not to be neglected, or which I felt ought not to be neglected. I was wondering whether April would be a better month than March. It would be a trifle later and still early enough so that the different gas companies would not have commenced their construction work for the spring and summer months.

MR. OSBOURNE:—It is purely for personal reasons that I would suggest August. I have troubles of my own which happen at other times. The spring of the year seems to every one else to be the best. August just happens to be a time that would best suit me, for a certain reason which I do not care to state. However, the spring of the year, or about the time we have selected seems to be all right. It is before spring work begins and after the winter troubles are over.

MR. KNIGHT:—The Wisconsin, Michigan and New England Associations this year, I believe, all meet on the same day. That ought not to be; but it is an evidence they consider that time of the year about the right time.

PRESIDENT McILHENNY:—The Michigan Association has changed its time to meet in September, I believe.

MR. COOMBS:—For one I am in favor of changing the meeting to a later date. Men connected with a gas company have to take care of a good deal of street work, and that work is generally demanding attention about the time this convention meets. I came pretty nearly having to stay at home this time. Of course, however, I am only one member of the Association and I would not ask that it be changed on my account. Speaking with reference to my personal convenience, however, I would like to see the date changed to either May or September.

PRESIDENT McILHENNY:—What is your opinion, Mr. Doherty?

MR. DOHERTY:—My opinion is, Mr. President, that the best time of the year is after the peak of the load is passed and before the construction work opens up and at a period sufficiently early to permit the adoption of any new business plans that may be brought to our attention at the convention. It is often desirable also to put off the purchase of stoves until you can meet with your friends at the convention. It seems to me that we have already selected the most appropriate time for our meeting, unless perhaps it would be better to have it a month earlier. A little later in the spring our new business campaign opens up. We are busy setting up stoves and selling them and we want to devote our entire energies to business while it is harvest time. All during the summer construction work is going on. In the fall that construction work is frequently unfinished. The load is increasing; and it has always seemed to me a bad time for the engineers and construction men and the managers to leave their plants at that time. From my observation I would think that February or March was the best month to meet, and possibly February would be better than March.

No. 402. What advantage is there in consolidating a gas and electric property in a city of 50,000 people?

J. H. Nelson:—The advantages are avoidance of competition and the ability to satisfy consumers desiring both gas and electricity, or one in preference to the other.

J. J. Knight:—I am not familiar with its advantage, but its disadvantage is that it furnishes the only reasonable foundation that exists for municipal ownership clamor.

J. H. Enright:—Concentration of management under one head.

One office, and up-to-date system of accounts, can handle business of both plants.

Eliminates underhand cutting of rates.

Good mechanical force, under one management, can distribute output from both plants more economically.

Being able to furnish gas or electricity current on call is an advantage also.

Irvin Butterworth:—Economy of operation resulting from both plants being constantly under the eye of one manager, and from the better utilization of power and of otherwise waste products from both plants.

M. T. Walker:—No advantage. Excepting in small towns where one manager and one set of clerks have the time to properly care for two plants, and it is essential that certain fixed expenses should be spread over a greater volume of business, I would not recommend consolidation.

E. M. Osbourne:—Cuts out competition. Reduces expenses by cutting down office force, etc.

No. 403. What is the best method of detecting or preventing thefts of gas?

S. E. Mulholland:—Going on the old theory that an ounce of prevention is worth a pound of detection, our management has placed locks on all meters and adopted the rule that all meters must be removed and stop-cocks at curb turned when gas is discontinued.

The invention of the meter lock was a step in the right direction, but until recently all locks on the market were only good for use once, as they had to be destroyed when removing meter; but now that locks are made that do not have to be broken and that can be renewed each time meter is reset by simply supplying a small key, the cost of which is practically nothing, it hardly admits of argument that the few cents additional required to protect meter and gas is one practical answer to the question as to the best means of preventing thefts of gas.

J. H. **Enright**:—Careful and systematic handling of output. Meter readers with some knowledge of house piping, and who can see more than the face of the meters when reading them, make good monthly inspectors. It is also well to make an example of the first fellow you catch stealing gas, as same will have a wholesome effect on others who wish to indulge.

Irvin Butterworth:—Instructing meter readers and all employes to be on the lookout for them, and offering them rewards for reporting them.

S. J. **Glass**:—In my opinion, frequent inspection of meters and connections at *irregular intervals* is one of the best methods for both detection and prevention of thefts of gas.

A standing offer to employes of a reward of $10.00 for each case of theft discovered will often aid in the detection of such cases.

The great majority of consumers are known to be above such a thing and for consumers whose reputation is questionable, where there is any uncertainty as to their reliability, I would recommend some sort of an inexpensive and effective "seal" upon the meter connections.

Meter connections should always be removed and service "capped up" when meters are taken out, and in addition, when possible, the gas turned off at the curb.

F. R. **Persons**:—By overhauling the meters as often as once in three years at least.

M. T. **Walker**:—Keep an "eagle eye" on the business and use locks on the meter cocks.

B. C. **Cobb**:—By having meter inspectors properly instructed to watch for such things, and by periodically inspecting premises known to be connected by service pipe where meters are not installed.

No. 404. What precautions should a gas company take to secure absolute ownership of services put in on consumers' premises so it would be impossible for a competing company to make use of them?

J. J. **Knight**:—A signed application from the owner of the lot for a free service embodying as a consideration a clear-cut contract protecting the gas company. If this will not do it, nothing will.

S. E. **Mulholland**:—Own service from the main to the meter.

F. R. **Persons**:—Take a sufficient release from property owner and file as a lien if necessary.

This practice becomes a necessity in case of natural gas or other competition.

Philo Jones:—Our contracts specify that all fittings remain the property of the gas company. On the last joint of pipe we fasten an "ownership" brass label.

W. A. **Aldrich**:—Where services are put in free, take a receipt acknowledging ownership of service to be vested in the company, and have same recorded.

B. C. **Cobb**:—Such a condition seems improbable. Before a service is laid, however, a signed application should be on file in the gas company's office explicitly stating that the service pipe, meter and meter connections are the property of the gas company.

Editor:—I do not think ownership of service pipe can be secured to a gas company in any other way short of a mortgage deed. A contact with a consumer would not bind a future property holder unless the lein was properly recorded. Tagging the service pipe with a notice that it is the property of the gas company might be construed sufficient notification to the new purchaser of the property if he could be compelled to admit that such notice was brought to his attention before his purchase.

A certain western gas company has attempted to cover the ownership of services on consumers' premises by including them in the mortgage on its property. This, together with a tag on the service claiming ownership of the gas company, might be considered sufficient notification. What a gas company wants is some way to insure the ownership of this service to the company and prevent its use by any other competing company. I am inclined to think that at best, even if ownership could be maintained to the company, the property owner could confiscate the service and the company could only demand damages for the service, which would be measured by the cost of installing that service and probably with a deduction for its depreciation.

ORAL DISCUSSION.

MR. KNIGHT:—I am inclined to think that you could protect yourself by having a mortgage upon it and making it a matter of record. But you would have to pay for it. You would have to give some consideration, I think.

MR. DOHERTY:—I think Mr. Knight is right that a mortgage would protect you, at least as far as ownership is concerned; but it is a question in my mind whether you could maintain your ownership if the property holders or another company wanted to confiscate it. I think you would only have a claim for damages, and the only complete protection to the gas company would be absolute ownership whereby they could prevent a competing company from buying the service. The people do not want their lawns torn up a second time to put in a new service. I am inclined to think that there would be danger of confiscation unless you could anticipate it and have it enjoined. Then it is up to you to go after them for damages.

PRESIDENT MCILHENNY:—Has that case ever been tested, Mr. Doherty?

MR. DOHERTY:—I do not know whether it has or not. The scheme I spoke of here is a scheme followed by a gas company in which I am interested and it puts it on record, and a foreign trust company can go into the federal court and say that they have been given a mortgage on that service pipe and that the usual process has to be gone through to get it out from under that lien.

PRESIDENT MCILHENNY:—I had an impression that it had been decided that no other company could take possession of the pipe belonging to another company which contained gas, up to the point at which the cock was set.

MR. OSBOURNE:—Wouldn't that be as great an offense as it would be for a prospective consumer to cut the pipe or interfere with it in any way?

No. 405. What records of value can gas companies secure from the meteorological bureaus?

E. J. CURLEY:—Record of dark days, rainy days and cold days, so as to remind consumers and offset any complaint against a supposed excessive bill.

EDITOR:—Barometric and temperature measurements are probably more accurately taken at the meteorological bureaus than at the gas plant, and the records from these bureaus might be advantageously substituted for the observations ordinarily made at the works. It is also customary to take sunshine records at these bureaus, and these sunshine records, if preserved from year to year, would show reasons for variation of send-out.

No. 406. What form of advertising has been found most productive for gas companies?

J. J. Knight:—Careful attention to complaints, a liberal amount of gratuitious work, and frequent "ads." in daily papers.

S. E. Mulholland:—The advertising that a first-class solicitor can furnish.

Irvin Butterworth:—Newspaper advertising.

F. A. Cressey, Jr.:—We have found newspaper advertising most productive.

E. Haase:—In the writer's experience nothing has equaled circular advertising. In circulars the element of quality is of first and last importance. Printing, illustrations and paper must be good and appropriate, the wording carefully chosen and the argument or statement well calculated to appeal to the needs of the recipient. The earnest appeal rather than the trivial, though bright idea, would be the most successful.

W. Hellen:—Prompt and efficient service and courteous conduct on the part of the employes.

M. N. Latta:—The writer has found "Street Car Ads." perhaps the most successful.

M. T. Walker:—Good service.

B. C. Cobb:—First—High grade and capable solicitors.

Second—Newspapers.

Third—Bill stickers and printing across face of gas bills.

F. W. Stone:—Newspaper advertising has been the most profitable to us if the space occupied was large enough to attract attention and the advertisements were gotten up in an attractive way. Newspaper advertising, however, demands careful, prompt and persistent attention. After newspaper advertising, we have had the best success with booklets which were devoted to some one particular branch of the business.

Henry S. Whipple:—Good newspaper advertising.

Clarence S. Lomax:—The companies I have been associated with have confined their advertising to newspaper advertising.

L. C. Stockton:—Our experience leads to the conclusion that a follow-up-mail campaign, supplemented by newspaper and street car advertising, produces best results. Profits, however, will be proportional to the skill of this campaign. To get accumulative results your advertising must be systematic, persistent and progressive. Keeping up velocity and momentum in a campaign is very important. Gas is something which may be made to appeal to the whole public, hence variety in the character of advertising is essential.

The effect of advertising upon the general attitude of the public toward your company, is something not to be overlooked. As a means of dispelling the popular delusion that a public-utility-corporation is a public menace and the common enemy of the integers of which the public is composed, advertising has great value. It tends to awaken the realization that after all a corporation, which is owned, controlled and operated by human beings with very human traits, is permeated with human characteristics, and therefor entitled to considerate treatment. The inviting courtesy which is inseparable from good publicity, impresses this lesson effectively.

No. 407. What is the permissible limit of error in consumers' gas meters?

J. Chas. Andrews:—"The laws of Massachusetts and Ohio define this standard, and in these States a meter is accepted as correct when registration of the measured volume varies not more than two per cent. in favor of the company, or from two per cent. to three per cent. in favor of the consumer. The 'Sales of Gas Act' in England likewise prescribes these limits. Michigan, I believe, has no regulation covering the accuracy of the meter. It is good practice to consider as correct a meter whose variation does not exceed one per cent. fast and one and one-half per cent. slow. The meter manufacturers will accept these limits in selling meters, and it is to the credit of the gas companies to require and maintain a higher standard of efficiency than is required by law."

The above is taken from a paper read by Mr. Paul Doty on "Meter Testing" before the seventh annual meeting of the Michigan Gas Association. Reference: *American Gas Light Journal*, March 19th, 1900, page 450.

New York & Richmond Gas Company:—The State of New York, by law, allows two per cent.

J. H. ENRIGHT:—It is always best to have meters register correctly; however, three per cent. either way on small meters is usually permissible.

B. F. BULLOCK:—One and one-half per cent. fast; two per cent. slow.

W. E. BROWN:—Two per cent. fast; three per cent. slow.

IRVIN BUTTERWORTH:—I have no fault to find with the old rule and custom originally established by the Gas Referees of London, that a meter should not be considered excessively in error if it is less than two per cent. fast, or less than three per cent. slow; but gas meters should be adjusted to register more nearly correctly than either of these extremes before being set.

JOHN T. BRADY:—From two to three per cent. Any variance above this, either in favor of or against the company, should be corrected upon discovery.

M. N. LATTA:—Two per cent. slow, one per cent. fast.

S. J. GLASS:—Some states have laws allowing a certain variation, either slow or fast, to be considered as correct.

Just why an exception of this sort should be made in favor of gas meters is more than I can account for. Possibly in the earlier days, before the present degree of perfection in the manufacture and testing of meters was obtained there might have been some excuse for such an allowance.

Cannot see that there is any such excuse in this day and age, and believe that when a meter is termed "O. K." or "Correct" that it should test neither fast nor slow. We cannot consistently claim that our meters are reliable instruments of measurement, and at the same time qualify their correctness by an allowance of some sort.

F. R. PERSONS:—Two per cent. either way in most states.

W. A. ALDRICH:—Two per cent. fast; three per cent. slow.

No. 408. Has anybody tried to apply the Taylor system of shop management to gas operations?

No. 409. What are the arguments for and against a gas company's owning its own coal mine and oil wells?

C. O. G. MILLER:—I believe, with the great majority of gas companies, one and a final argument against owning its own coal mine and oil wells is the lack of sufficient capital. In some states I think the franchise of a gas company will not allow it to operate a coal mine or oil wells. Even in cases where the law permits and the stockholders are willing to furnish the funds, I doubt whether a gas company can produce coal from its own mine as cheaply as it can buy in the open market.

J. J. KNIGHT:—If the gas works are so located and of sufficient size to make it profitable to own and operate a coal mine or oil well there is no argument against it; if not, no argument in favor of it.

S. E. MULHOLLAND:—Speaking for a company that owns its own oil well drilled on its own property, within a few feet of its Lowe apparatus, there does not seem to be any argument to be made.

No. 410. Which is the better plan, to exact a deposit from every consumer, or simply from those considered poor pay?

C. HENRY IRWIN:—I have endeavored to exact deposits from all who are not property owners, but find it a difficult matter in many cases. Well-to-do people object as a matter of principle. I have known tenants to require the landlord to pay their gas bills during the summer months rather than to pay a deposit. Women will talk about deposits to pass the afternoon away with their neighbors, and if a deposit has been collected from one woman and not from her neighbor, the company will certainly have a chance to explain the reason why the first time that lady is down town. If it were not for deposits at summer resorts with their floating population, there would be considerable loss. I have always noticed that a consumer who puts up a stiff fight against paying a deposit needs watching. I would recommend that the matter of collecting deposits be left to the discretion of the proper representative of the company who is acquainted with all details governing the same.

J. H. NELSON:—Deposits should be exacted only from those consumers considered poor pay. It is a poor plan under any circumstances, as good pay consumers regard it as unusual and an imposition.

HARRY MCKAIG:—I would say that the ideal plan in my judgment is to exact a deposit from each and every consumer, that is, if a deposit is exacted at all from any consumer, for as a public corporation, we should treat all consumers legally alike. In summer resorts there is a varied and changing population, "here today and gone to-morrow," hence the necessity of a company being protected by a deposit. I would suggest, as a plan of equity for consumers of a year or longer standing, that they be allowed interest on their deposits at the close of each full year and that no fraction of a year's interest be allowed thereafter. Allowing interest only to consumers continuing to use gas for a full year and allowing no interest on fractional parts of a year serves the purpose of being fair with all consumers, but saving an immense amount of time computing interest, and also saving money. The company, in making itself safe by exacting the deposit from all, would have very much fewer "bad and doubtful debtors" to charge off their ledgers. Consumers already on the company's books, I think should remain as they are at present, but in the event of their being discontinued as consumers for non-payment of bills or in any other way become a non-consumer, the deposit should be exacted should they again make application for a meter set. In this way all the poor-paying consumers would be eventually culled from the company's business, or protection given by a deposit. As to the amount of the deposit necessary for the company's protection, I think it should be regulated by the capacity of the meter set. In the summer resorts where the proprietors of hotels and large boarding-houses are simply meter renters and not holders of property in the town, I suggest that a weekly bill be sent and payment required within a week or ten days thereafter or service discontinued.

This arrangement, I believe, would do away with many of the hard questions with which the collection department has to deal.

Chas. S. Ritter:—In towns of 25,000 or less, where practically every gas consumer is personally known to the company, a deposit should rarely ever be necessary; in those cases only in which persons are known to be poor pay.

In larger cities the necessity of a deposit increases with the size and character of the city. A good rule for a large city might be, "when in doubt require a deposit." The customs of other merchants in the same city, will have much to do with the deposit question. Your patrons get their education on the "credit system" from the environment in which they are placed, and you will do well to adopt a plan that will neither be offensive to them, nor too liberal. Owners of property, and all persons known to be responsible, should not be required to make a deposit.

J. J. Knight:—Unless your ordinance provides that you may do so, you probably cannot legally require a deposit from anybody.

The better way is to take your chances, and in exceptional cases use a prepayment meter.

W. V. SPINNING:—Only those considered poor pay or to transient residents.

S. E. MULHOLLAND:—I consider it the best plan to exact a deposit or guarantee endorsement from every new consumer, who becomes delinquent, before taking them on again.

S. E. BAKER:—To ask a deposit from every prospective consumer will keep down the number of meters in service. A canvasser can solicit with greater success if all the house-holder has to do is to sign a meter application, but when the house-holder is asked to make a deposit he often thinks that he will let "well enough" alone.

There are parts of every city in which experience has shown that many bills are left unpaid. In such a section it is a good rule to require a deposit of everybody; a blanket rule like this may bear heavily upon a few, but in a neighborhood that is known to be poor pay one cannot afford to discriminate. In determining who shall pay deposits, a knowledge of the city is a great help; for example, one might feel that a millinery store had a good chance for success where a grocery store would fail. In this case, of course, the millinery store's meter should be set without a deposit and the grocery store would be called upon to pay one. There are some stores in which no business seems to succeed; for these locations a deposit should always be required. Let one man have the final decision whether a party shall or shall not make a deposit, and the responsibility will make him conservative and his experience will give him judgment which will be of great value.

J. H. ENRIGHT:—In medium and small sized towns, where the manager usually has a large personal acquaintance, it is not difficult to keep in touch with financial condition of consumers.

In these days of competition and the advocacy of municipal ownership, I believe it to be unwise to demand a deposit in every case. However, it may be well and necessary to do so in the larger cities.

B. F. BULLOCK:—Exact a deposit from those not owning property, or not having a property holder go as his security; otherwise put in a prepayment meter.

JOHN T. BRADY:—From those only considered poor pay. The amount of money received as deposit usually draws a high rate of interest and is of little use to the company. The man who is called upon to deposit a sum of money as security that he will pay his bills is not only oftentimes incensed at the idea itself, but usually inclined to allow the bills to run until they equal, if not exceed, the amount deposited; and this class of people, as a rule, are poorer pay than those of good standing in the business world who are taken at a rating or furnish a guarantor.

W. E. **Brown**:—Deposits drive away customers. If poor pay, set a slot meter.

Irvin Butterworth:—A gas company can afford to take long chances, and no deposit should be required, except from those who are considered very poor pay.

Philo Jones:—We exact a deposit from all tenants, or require the name of a property owner as guarantor. No deposit is required of a consumer if owner of premises.

W. **Hellen**:—Ask a deposit from those considered poor pay, only.

M. N. **Latta**:—This should be based on the same principle as any other credit system. It is decidedly unnecessary to require deposits of property owners or other parties given proper financial reference.

B. C. **Cobb**:—From the consumer considered poor pay—if any deposit is asked.

M. T. **Walker**:—From those considered poor pay.

E. M. **Osbourne**:—From those only who are considered unsafe.

No. 411. How far is it advisable to go toward free repairs and maintenance of house-service, piping and burners?

S. E. **Mulholland**:—This is a good deal like Hancock's remark about the tariff, being a local issue, the tendency being with no competition to do nothing, and with extremely hard competition to do everything for the consumer.

It would appear that under normal competition or conditions that those things, which while inexpensive, mean securing, holding or satisfying a consumer, cannot be allowed to remain undone or unfurnished by a gas company awake to its own interests; and while we cannot yet agree with the enthusiastics, who go so far as to say that the gas companies should pipe, free of charge, buildings that are not using gas for illumination, yet, when the probable life of the building is taken into consideration and the possible or probable gas sales per annum, it is seen that after one, two or three years, the profit on the gas sold has repaid the actual cost of the piping, after which there is a continued sale of gas in the building that is to the company's advantage for a good many years to come.

The writer questions the advisability of the gas company making so large an original investment as would be required for the free piping of houses; although the tendency of the times is unquestionably such as to bring us face to face with this proposition before many years.

B. C. Cobb:—Entire expense of maintaining service pipe. House-piping and burner maintenance at expense of consumer, except when it is only necessary to blow out piping or clean burners and renew lava tips. This, however, is a question that must be governed by local conditions, for in some individual cases it may be advisable to make extensive repairs and alterations.

No. 412. About what proportion of the gas companies of the United States sell gas for power at a lower price than for fuel? Or better still, give a complete list of such companies.

Irvin Butterworth:—A circular letter of inquiry sent out during January, 1904, to all gas companies in the United States operating in cities of 25,000 inhabitants or over, brought replies showing that the gas companies in the following cities charge a lower price for gas used for power than for the same gas used for fuel.

As some of the companies did not reply, the list may not be quite complete for cities of the size mentioned, and of course the companies in some of the smaller cities, not inquired of, may also make differential prices for power and fuel gas:

Clinton, Mo.
Topeka, Kans.
Ottawa, Ill.
Chelsea, Mass.
New Bedford, Mass.
Altoona, Pa.
Saginaw, Mich.
Grand Rapids, Mich.
Utica, N. Y.
Valparaiso, Ind.
Superior, Wis.
Fond du Lac, Wis.
Omaha, Neb.
Duluth, Minn.
Rome, N. Y.
New Britain, Conn.
Rockford, Ill.
Michigan City, Ind.
Binghamton, N. Y.
Auburn, N. Y.
Syracuse, N. Y.
Savannah, Ga.
Chester, Pa.
Council Bluffs, Ia.
Freeport, Ill.
Jacksonville, Fla.
New Orleans, La.
Marlboro, Mass.
Ottumwa, Ia.
Detroit, Mich.

The following is a partial list of cities in Great Britain in which gas is sold at a lower price for power than for fuel:

Widnes.
St. Helena.
Glasgow.
Manchester.
Wigan.
Sheffield.
Prescott,
Wolverhampton.
Runcorn.
West Hampton.

No. 413. Is it wise to allow your meter readers or inspectors to give any information to your consumers?

W. W. Frost:—No.

J. J. Knight:—No.

F. Tobey, Jr.:—We think it wise for our meter inspector to give consumers information, when requested, but to be sure his information is correct and that he does not volunteer any.

W. V. Spinning:—Depends on the man. If he is accurate, yes; if not, no.

No. 414. What kind of a light is best for a meter reader or inspector to carry?

J. J. Knight:—A conductor's lantern.

C. H. Williams:—A light which has proven very satisfactory for meter readers is the "Ever Ready," 1½" x 8½" cylindrical lamp, which has a battery of sufficient capacity to hold up all day on the service which is required of it in reading meters. The meter man carries it under his arm, which gives him the use of both hands in handling his meter cards.

J. H. Hagerty:—Electric flash light, pocket size.

W. V. Spinning:—Electric flash light. It makes customers think you are careful.

ORAL DISCUSSION.

Mr. Stone:—Mr. President, none of the methods suggested appear to me to be very satisfactory. Our meter readers seem to consider the electric flash-light rather unhandy. It may be they are not as skilful as some others, but they say they find considerable trouble in holding it under their arm and doing the necessary work required to read the meter. It occurred to me there might be some other kind of a safety lamp that was better than anything advocated in the Question Box.

Mr. Donald McDonald, Louisville, Ky.:—Mr. President, it seems to me the meter reader or inspector ought not to use a safety lamp. If there is any escaping gas I would rather it would be discovered while my man was there than at any other time. For that reason I make my men read our meters by means of a match, and when they read the meters they are instructed to run around the connections to see if there is any leak or if there is any gas escaping in the cellar in sufficient quantities to be liable to produce an explosion. If there is the meter man will notice it a good deal quicker than the householder. If it is not safe enough to light a match it is not safe enough to be left in that condition.

MR. J. M. ROBB, Peoria, Ill.:—I think the reason that gas men are looking for a safety appliance is not for the reason that was suggested by Mr. McDonald, but on account of the large quantity of inflammable material frequently stored in basements where the inspector is required to go in order to read the meter. We all know that matches are liable to start fires, and for that reason we have tried to use the electric flash-lamp. We have not found it very satisfactory. Our meter readers seem to prefer an ordinary conductor's lamp which is carried under the arm, thus giving free use to both hands. We have found the conductor's lantern the most satisfactory.

MR. BUTTERWORTH:—Mr. President, I think by all means that we should use the electric lamp. I think Mr. McDonald's method is very bad practice. I do not think it is the right way to do it at all. I think the meter reader should have a good nose and notice the odor of the gas when it is escaping and report it immediately, but that he should not be permitted to strike a match around the meter under any circumstances. I think Mr. McDonald is "breeding trouble" by any such suggestions.

MR. McDONALD:—In order to prevent an attempt on the part of some of my friends in swearing out a writ for an inquest of lunacy on me I would suggest that a good many members of this Association, I understand, are selling natural gas which they claim has no odor and therefore the suggestion of my friend who has just spoken is not applicable.

MR. BUTTERWORTH:—I am sure that the members here would interpret from Mr. McDonald's remarks that he would recommend his method for artificial gas also.

MR. STONE:—I would like to ask if any member knows of an electric flash-lamp that is better than the ordinary cylindrical flash-lamp commonly used? The electrical flash-lamp would be much more satisfactory if we had something that the meter readers could handle easily. I do not know but what possibly there was some miners' safety lamp or something of that kind.

MR. OSBOURNE:—If meters were placed in accessible places at all times then the problem would not be so hard to solve. But we frequently have to put the meters where the consumer wishes it put. Considering the stairways that the meter reader has to go down and the barrels and other rubbish he has to climb over, it seems to me that a conductor's lantern or something of that kind is the best. I have tried them with very satisfactory results. They give plenty of light and obviate many of the difficulties complained of.

MR. E. J. SHERWOOD, Lincoln, Neb.:—I would like to ask Mr. Butterworth if he considers the electric flash-light has any advantages over a lantern in regard to igniting gas. It seems to me the flash-light would ignite it as quickly as a lantern.

MR. BUTTERWORTH:—I should think it does have a decided advantage, Mr. Chairman. I think it is a perfectly safe device for the purpose.

MR. H. G. OWENS, Coshocton, Ohio:—In our town we have natural gas. We find that the electric flash-light is not very satisfactory with us. We have found them rather an expensive affair. As a rule when it comes time to read our meters before we get through reading them our flash-light is deteriorated so that there is very little benefit to be obtained from it. Therefore we use an ordinary lantern. We instruct our meter readers to be very careful, of course, and if they detect gas in going into the basement or any place where it has been closed up tightly they are instructed to investigate first before taking the lantern in.

MR. E. H. SCHNIERLE, Salem, Ohio:—Mr. President, I wish to say that I have had considerable experience in meter reading myself and have used most everything from Mr. McDonald's matches up to Mr. Butterworth's flash-light. We find the flash-light very unsatisfactory. Its usefulness is limited. We are using a lantern and I find that we get the best results from the use of an acetylene bicycle lamp. It gives a brilliant light. The meter reader can put a bail on top of it and hang it on his arm when he goes down a basement stairs and there is a light ahead of him. If there is any gas escaping he will detect it the instant he opens the door at the head of the stairs.

MR. GEORGE W. BARNES, Pittsburgh, Penn.:—After a number of years looking around trying to find a suitable lamp from every point of view, which will insure safety, durability and convenience. taking all things into consideration and after trying almost everything put on the market, including most of the new patents that have come out, we got into communication with the makers of the so-called Humphrey-Davies lamp at Scranton, Pa., and had them put us up a special lamp, a little larger than the miner's lamp, with a bail large enough to hang over a man's arm. We find it will burn all day with one filling of high grade sperm oil. The first cost of the lamp, I think, was possibly something like seven dollars. They will last a long time. They are practically indestructible, except that a globe may occasionally break. We have had these lamps in use for a number of years. They have given very good satisfaction. They are absolutely safe. You can get them made in two forms, either with an open face or a bull's-eye light. The bull's-eye light will give you a focus light at a distance of about 10 feet, covering a space of perhaps 8 feet. We have found these lamps very satisfactory.

PRESIDENT McILHENNY:—Where can they be obtained?

MR. BARNES:—I could not tell you just at present. The ones we had were made at Scranton by a firm who makes miners' lamps. They are large manufacturers of miners' lamps of the Humphrey-Davies pattern. They are so constructed as to detect the presence of gas, particularly natural gas which, to a certain extent is odorless. When there is sufficient gas in the room to cause an explosion the lamp will tell you of it. It is absolutely safe, very convenient and very durable. We have some of these lamps now that have been in use for a number of years without renewing excepting an occasional globe which may get broken.

MR. STONE:—I am much obliged to Mr. Barnes, for I think he has given me what I was after when I started this discussion.

MR. BARNES:—I might further add that the lamp we first had made was of a special pattern. I presume that anyone can have them now made from this same pattern. They weigh, I think, about 9.5 ounces.

MR. DOHERTY:—I might comment on that question, Mr. President, by saying that there is one electric flash-light made where the batteries are separated from the lamp. The lamp is contained in a small lense, not much larger than a No. 18 watch, which is put upon two fingers. You can press them together and you can have your light and still have the use of your hand. It also gives you a larger battery than you could conveniently carry in your hand because it can be put in the pocket or strapped on the person. I do not know who makes the lamp. The man who showed it to me was C. H. Williams, General Superintendent of the Madison Gas & Electric Company, Madison, Wis. I might say, further, in response to Mr. Sherwood's question about the relative safety of these lamps and a lantern, that I have attempted to determine whether an ordinary flash-light was safe. I have taken it into a dark room and have made the contact, but have never been able to see a spark. So that I think it is perfectly safe. If there were any doubt about it it would be an easy matter to protect it with gauze on the principle of the Davis safety lamp, where the temperature in going through the gauze would be reduced below the point of ignition.

No. 415. Is it customary to charge for thawing out gas pipes on customers' premises?

C. H. WILLIAMS:—It is not customary at Madison, Wisconsin, to make any charge for thawing out gas pipes on consumers' premises.

F. TOBEY, JR.:—No, unless they refuse to take obvious precautions, when informed of the necessity.

J. J. KNIGHT:—Not in Michigan.

W. V. SPINNING:—We do not. I do not think so.

HENRY S. WHIPPLE:—No charge has ever been made here (Rockford, Ill.).

MISCELLANEOUS.

No. 451. Are there any tables, and where can they be found, giving the properties of saturated vapors of the different hydrocarbons, such as C_6H_6, showing their specific heat at constant volume and constant pressure, the latent heat of vaporization and the temperature of vaporization at various pressures?

BENTON DALES:—There are tables giving many of the properties of vapors of different substances in any good set of chemical tables. Two such sets are:

1. Physico-Chemical Tables. By John Castell-Evans. Volume 1—Chemical Engineering and Physical Chemistry. (J. B. Lippincott Co., Phildalephia, 1902.)
2. Chemiker-Kalendar. By Dr. Rudolph Biedermann. (J. Springer, Berlin. Each year. May be obtained from Lemcke and Buechner, 812 Broadway, New York City, and probably from other book importers.)

No. 452. What is the spherical candle power of an incandescent gas lamp?

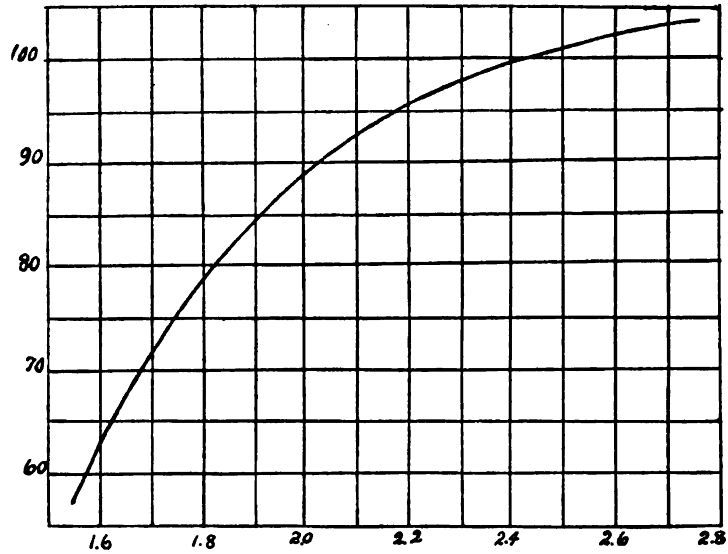


FIG. XII.

J. Chas. Andrews:—The following are extracts from the "Fourth Progress Report of the Committee for Investigating the Photometric Values of Arc Lamps," presented to the National Electric Light Association at its twenty-sixth convention, May 26th, 27th and 28th, 1903. Committee—Henry L. Doherty, Chairman; W. E. Goldsborough; C. P. Matthews, Photometrist.

The work was accomplished by Mr. C. P. Matthews with a Matthews integrating photometer. A full account of these tests can be found in the proceedings of the National Electric Light Association, twenty-sixth convention, page 442.

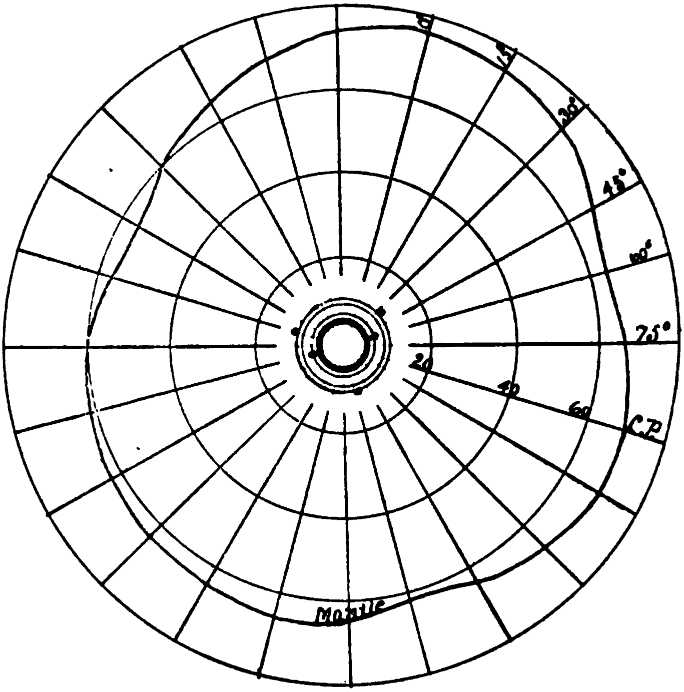


FIG. XIII.

"The mantles were classified according to their retail price as follows:

"Class A—Retail price, 35c to 60c.
"Class B—Retail price, 20c to 30c.
"Class C—Retail price below 20c.

"That the candle-power of a gas mantle is dependent in a marked degree upon the gas pressure is clearly shown in Fig. 12, which exhibits the candle-power in a horizontal direction for different gas pressures ranging from 1.6 to 2.8 inches of water. These results were obtained with the orifice of the burner so adjusted as to give maximum candle-power for each pressure.

"Fig. 13. shows the horizontal distribution of candle-power about an ordinary gas mantle mounted in a burner having three side supports for the mantle. It is clear that the distribution would be practically a circle were it not for the screening effects of these supporting rods. It will be noted that there are three depressions in the curve corresponding to the positions of the rods. The minimum horizontal candle-power in this instance is about 57, the maximum about 76.

CLASS "A"—INCANDESCENT GAS MANTLES.

ANGLE	CANDLE-POWER				
	No. 9	No. 10	No. 11	No. 12	Mean
75°A	29.4	26.4	28.3	25.8	27.5
60°A	37.8	38.8	38.4	37.5	38.2
45°A	55.6	55.8	57.5	61.3	57.6
30°A	64.0	60.9	64.8	68.6	64.6
15°A	77.6	68.6	76.0	83.0	76.3
Hor.	67.4	62.2	68.8	74.1	68.1
15°B	64.4	59.3	68.0	63.5	63.8
30°B	63.0	57.0	68.5	66.4	63.7
45°B	53.5	45.0	52.0	49.0	49.9
60°B	36.4	26.4	24.9	29.2	29.2
75°B	3.7	3.5	3.5	3.6	3.6
Cubic Feet Gas used per Hour	3.6	3.33	4.0	4.24	3.79
Mean Hemispherical Candle-power:					
Upper	60.0	56.5	60.4	59.2	59.
Lower	54.1	47.9	55.0	53.4	52.6
Mean Spherical Candle-power	57.1	52.2	57.7	56.3	55.8
Cubic Feet of Gas used per Mean Hemispherical Candle-power:					
Upper	.060	.059	.066	.071	.064
Lower	.066	.069	.073	.079	.072
Cubic Feet of Gas used per Mean Spherical Candle-power	.063	.064	.069	.075	0.68

"In the above table are to be found the results of tests of four samples of Class "A" mantles, inclosed in a clear glass chimney, but without other globe or shade. This wing-shaped distribution of candle-power in a vertical plane is characteristic of the ordinary mantle. The maximum candle-power is found at about 15 degrees above the horizontal, because from this point of view the visible area of incandescent surface is probably a maximum. The mean gas consumption for Class "A" mantles working under a pressure of two inches of water is 3.79 cubic feet per hour.

CLASS "B"—INCANDESCENT GAS MANTLES.

ANGLE	CANDLE-POWER						
	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	Mean
75°A	28.8	29.1	24.6	20.5	26.7	26.7	26.0
60°A	44.1	45.5	36.5	32.2	38.2	37.6	39.0
45°A	68.8	58.5	55.3	51.4	56.5	55.4	57.7
30°A	78.7	71.6	65.3	57.4	63.0	63.2	66.5
15°A	85.0	85.0	78.0	68.5	71.8	74.0	77.1
Hor.	84.5	77.1	66.9	62.0	64.1	66.0	70.1
15°B	83.0	70.8	62.6	56.5	62.0	62.1	66.3
30°B	80.4	74.0	64.8	63.0	66.7	65.0	69.0
45°B	69.6	63.3	55.3	53.8	52.6	52.7	57.9
60°B	39.0	33.3	30.8	29.0	28.0	38.6	33.1
75°B	4.1	3.5	3.6	3.6	3.8	4.0	3.8
Cubic Feet Gas used per Hour	4.1	3.36	4.13	3.43	3.43	3.49	3.66
Mean Hemispherical Candle-power:							
Upper	70.4	66.3	59.8	53.4	58.1	58.6	61.1
Lower	68.5	60.8	53.4	50.5	52.9	52.8	56.5
Mean Spherical Candle-power	69.5	63.6	56.6	51.9	55.5	55.7	58.8
Gas used per mean Hemispherical Candle-power:							
Upper	.058	.051	.069	.064	.059	.059	.060
Lower	.060	.055	.077	.068	.065	.066	.065
Gas used per Mean Spherical Candle-power	.059	.053	.073	.066	.062	.063	.062

CLASS "C"—INCANDESCENT GAS MANTLES.

ANGLE	CANDLE-POWER		
	No. 1	No. 2	Mean
75°A	34.7	33.0	33.8
60°A	42.0	43.3	42.7
45°A	59.8	61.6	60.9
30°A	70.6	71.5	71.0
15°A	78.5	84.2	81.3
Hor.	75.0	74.0	74.5
15°B	71.3	71.0	71.2
30°B	70.0	72.5	71.3
45°B	56.1	57.1	56.6
60°B	33.3	36.6	34.8
75°B	3.4	3.5	3.5
Cubic Feet Gas used per Hour	3.83	4.14	3.99
Mean Hemispherical Candle-power:			
Upper	64.8	66.6	65.7
Lower	58.0	59.1	58.6
Mean Spherical Candle-power	61.4	62.9	62.2
Gas used per Mean Hemispherical Candle-power:			
Upper	.059	.062	.061
Lower	.066	.070	.068
Gas used per Mean Spherical Candle-power	.062	.066	.064

"The two foregoing tables give the results of tests on mantles of Classes 'B' and 'C.' The six samples of Class 'B' show a considerable lack of uniformity.

"Plotting now on one sheet the mean candle-power distribution obtained from each of the three classes (Fig. 14), it is seen that the more expensive mantles give the least candle-power. Whether this is a general conclusion or not cannot be said without a larger number of tests than are here described. In point of gas used per mean spherical candle-power, Class 'B' leads Classes 'C' and 'A,' following in the order named. The real economy of one grade of mantles over another cannot be told without a life test.

"The effect upon the candle-power distribution of the mantle burner of different types of shades is very clearly shown in Fig. 15. The figure shows the alteration in the shape of the candle-power curve produced by the use of two types of porcelain shade, indicated in the figure, and one type of holophane globe.

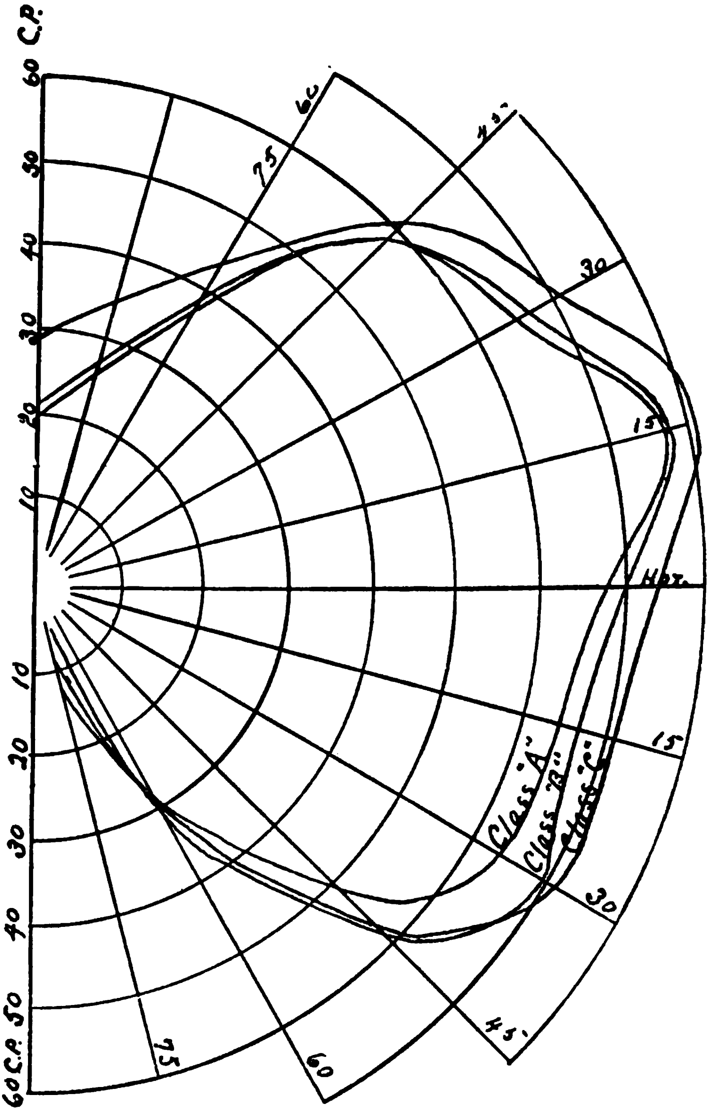

60 C.P.
50
40
30
20
10
10
20
30
40
60 C.P. 50
75
60
45°
30
15
Hor.
15
30
45°
60
75
Class "A"
Class "B"
Class "C"

FIG. XIV.

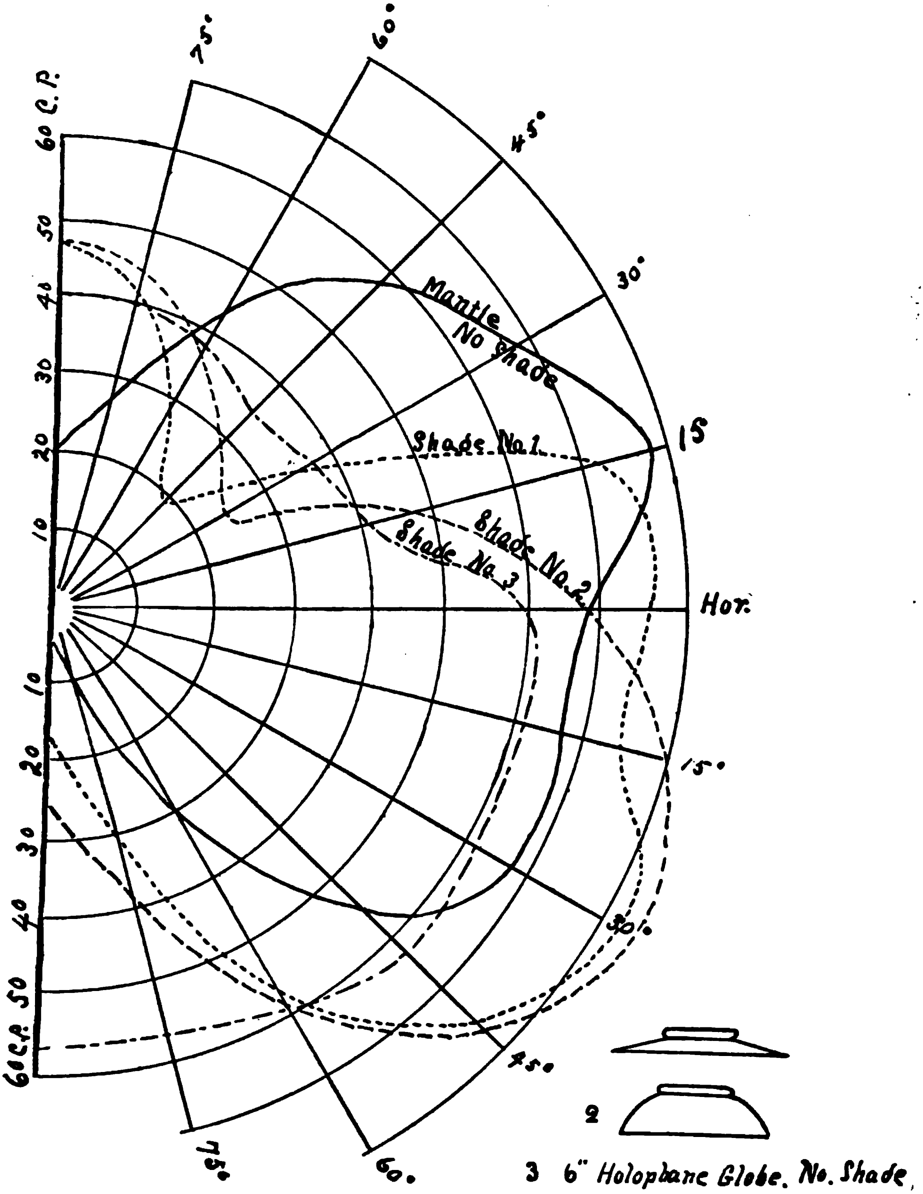

75°
60°
45°
30°
15
Hor.
15°
30°
45°
60°
75°
60 C.P.
50
40
30
20
10
10
20
30
40
50
60 C.P.
Mantle No Shade
Shade No. 1
Shade No. 2
Shade No. 3
2
3 6" Holophane Globe. No. Shade,

FIG. XV.

INCANDESCENT GAS MANTLE WITH SHADES.

ANGLE	CANDLE-POWER			
	Without Shade	Shade No. 1	Shade No. 2	Shade No. 3
75°A	26.30	41.20	54.12	39.70
60°A	42.85	29.45	36.78	37.80
45°A	58.65	18.22	30.00	35.30
30°A	68.35	33.76	23.50	37.17
15°A	78.60	71.15	47.26	40.65
Hor.	68.42	75.91	67.97	59.59
15°B	67.15	74.40	80.40	61.20
30°B	67.00	82.75	85.30	61.26
45°B	53.75	75.55	77.10	62.68
60°B	28.80	55.85	58.00	58.33
75°B	3.70	29.80	38.20	56.50
Cubic Feet Gas used per Hour	3.75	3.75	3.75	3.75
Mean Hemispherical Candle-power:				
Upper	62.60	46.00	40.40	41.00
Lower	55.20	71.20	76.20	61.20
Mean Spherical Candle-power	58.90	58.60	58.30	51.10
Gas used per Mean Hemispherical Candle-power:				
Upper	.060	.082	.093	.092
Lower	.068	.053	.049	.061
Gas used per Mean Spherical Candle-power	.064	.064	.064	.073

"An inspection of the figures for mean spherical candle-power in the above table shows that the use of porcelain shades on a mantle burner is accompanied by very slight reduction of total flux of light from the source. The absorption produced by the holophane globe is about 13 per cent."

J. J. Knight:—The mean spherical candle-power of the average individual incandescent gas light is probably about 70. The highest type of the gas arc lamp, using four mantles, is from 400 to 450.

L. F. Curtis:—Spherical candle power is the same as that of a single ray or bundle of raps as taken by ordinary photometry.

No. 453. What is the spherical candle-power of an open-flame tip?

J. Chas. Andrews:—"Following are the results of a short series of tests of the candle-power and gas consumption of the ordinary open gas flame:

TABLE SHOWING VARIATION IN SIZE OF ORIFICE OF OPEN-FLAME LAVA TIPS

Nominal Rating of Tip	Pressure of Gas in Inches of Water	Horizontal Candle-power Normal to Flame	Cubic Feet of Gas used per Hour
1 Cubic Foot......	1.2	18.50	6.15
	1.2	14.90	6.66
2 Cubic Feet......	1.2	4.85	5.30
	1.2	3.60	3.33
3 Cubic Feet......	1.2	13.20	6.70
	1.0	22.50	8.30
	1.2	11.70	7.06
	1.2	9.45	6.70
	1.2	30.20	15.70
	1.3	29.20	16.15
4 Cubic Feet......	1.0	12.68	6.49
	1.0	18.80	8.20
	1.2	17.00	5.71
	1.2	16.10	8.06
	1.2	17.85	9.30
	1.2	9.10	6.90
	1.2	14.70	6.50

"The above table gives the results of a number of tests on tips supposed to admit of a consumption of gas ranging from one to four cubic feet per hour according to their marking. It will be seen that in some cases a one-foot tip gives as high a candle-power as a four-foot tip with no higher gas consumption. Apparently the classification adopted is a meaningless one.

"The following table gives the complete results of a series of tests of candle-power and gas consumption of five tips operated under a gas pressure of 1.2 inches of water. In this table the distribution of candle-power is given in two vertical planes, respectively parallel and normal to the broad side of the flame. These are referred to as 0 degree and 90 degrees respectively. The mean of the two candle-power readings is also tabulated. Tips Nos. 2 and 5 represent extreme conditions; 1, 3 and 4 represent more nearly average conditions."

The above answer to question No. 453 is taken from the same source as the answer to question No. 452, and can be found on page 459 of the Proceedings of the twenty-sixth convention of the National Electric Light Association.

The gas fraternity is much indebted to Professor C. P. Matthews and his assistants, Paul G. Winter and Terry T. King, for the above data.

OPEN GAS FLAME—Pressure 1.2″ of Water.

	CANDLE-POWER.						CANDLE-POWER.								
	Tip No. 1.			Tip No. 2.			Tip No. 3.			Tip No. 4.			Tip No. 5.		
	0°	90°	Mean 0° and 90°	0°	90°	Mean 0° and 90°	0°	90°	Mean 0° and 90°	0°	90°	Mean 0° and 90°	0°	90°	Mean 0° and 90°
75°A	15.77	19.30	17.54	6.02	6.70	6.36	13.33	10.78	12.06	20.85	20.35	20.60	30.6	33.6	32.1
60°A	13.39	17.27	15.33	6.90	5.23	6.07	10.40	10.80	10.60	15.12	17.68	16.40	26.2	29.4	27.8
45°A	15.37	14.40	14.89	6.27	5.07	5.67	9.82	10.52	10.17	14.91	16.43	15.67	26.8	29.4	28.1
30°A	13.90	14.46	14.18	5.96	6.49	6.23	11.21	10.86	11.04	17.02	19.15	18.09	26.4	29.8	28.1
15°A	15.00	16.09	15.55	6.16	6.03	6.10	11.01	10.92	12.97	19.10	21.00	20.05	26.3	31.3	28.8
Hor	12.00	14.85	13.43	5.46	4.99	5.23	9.85	9.55	9.70	15.20	18.00	16.60	25.1	29.7	27.4
15°B	11.51	12.27	11.89	4.44	4.76	4.60	9.11	8.94	9.03	13.22	13.73	13.48	22.9	27.1	25.0
30°B	12.82	12.96	12.89	5.99	5.30	5.65	10.20	11.67	10.94	15.15	16.40	15.78	26.6	30.8	28.7
45°B	13.82	17.46	15.64	5.26	6.33	5.80	9.04	11.22	10.13	18.02	21.73	19.88	29.7	36.3	33.0
60°B	13.43	17.80	15.62	5.24	6.49	5.87	8.95	11.92	10.44	16.90	18.20	17.55	28.0	38.6	33.3
75°B	12.42	15.85	14.14	4.41	7.41	5.91	7.59	12.63	10.11	11.80	19.18	15.49	27.4	29.2	28.6

	Tip No. 1.	Tip No. 2.	Tip No. 3.	Tip No. 4.	Tip No. 5.
Cubic Feet Gas used per Hour	5.75	3.64	4.45	6.20	9.7
Mean Hemispherical Candle-Power:					
Upper	15.00	6.00	10.67	17.96	28.60
Lower	13.88	5.42	9.93	16.38	29.20
Mean Spherical Candle-Power	14.44	5.71	10.30	17.17	28.90
Cubic Feet Gas used per Mean Hemispherical Candle-Power:					
Upper	.384	.607	.417	.345	.339
Lower	.414	.672	.448	.378	.332
Cubic Feet Gas used per Mean Spherical Candle-Power	.399	.639	.432	.362	.330

J. J. Knight:—I assume the person asking this question wishes to know what the mean spherical candle-power of an open gas flame is. If burning properly, it will be about 3 candle-power per foot of gas consumed.

No. 454. What is the specific heat of gas oil?

No. 455. What is the temperature of vaporization of gas oil?

No. 456. What is the heat of vaporization of gas oil?

No. 457. What is the specific heat of the vapor of gas oil at constant pressure?

No. 458. How many factories are now making large gas engines?

J. Wallace Shaeffer:—There are only about five concerns in the United States manufacturing gas engines of large units.

No. 459. Please give a list of the factories making large gas engines.

J. Wallace Shaeffer:—The companies building large engines in the United States are:

Allis-Chalmers Company	260 to 6,000 B. H. P.
Westinghouse Machine Company	up to 5,000 B. H. P.
Loomis-Pettibone Gas Mach. Co.	up to 2,000 B. H. P.
Snow Steam Pump Company	500 to 5,000 B. H. P.
Wellman-Seaver-Morgan Company	500 to 6,000 B. H. P.

The Snow Steam Pump Company is the only one of these concerns that has built an engine of the 5,000 B. H. P. rating. All the other factories are, however, prepared to contract for engines up to the higher units set opposite their names.

No. 460. What text books should be studied to enable the reader to intelligently erect a plant and manufacture anhydrous ammonia and other refined ammonia products?

No. 461. Is there really any room for the great number of gas associations we now have ?

Alton Light & Traction Co.:—This corporation or its President belongs to eight different associations or engineering societies, and it is our belief that one Eastern, one Central and one Western Association would meet all the requirements, provided the Secretary of each Association gave his entire time to Association work.

IRVIN BUTTERWORTH:—Yes, if they will better systematize and direct the work of their members.

M. N. LATTA:—The writer is in favor of fewer associations and a larger work; this will reduce fixed charges and increase the usefulness of the work.

F. R. PERSONS:—I believe a consolidation of certain ones would be of benefit to all concerned.

W. A. BAEHR:—I think the state gas associations and smaller gas associations in general are very helpful to those men in the gas business who have not the opportunity to attend the big association meetings and for the young men who are starting in the gas business.

However, for the members of the profession who desire more advanced work and whose aim is to conduct scientific research work, I think the great number of small associations is a distinct drawback. For this latter class of men I would suggest that a gas institute be formed, whose work would be on a par with that of the American Society of Mechanical Engineers, the American Society of Civil Engineers and the American Institute of Electrical Engineers. By forming such a gas institute, it would give the members who desire advanced work an opportunity to do same, and it would be advisable to make the requirements for admission to such an institute rather difficult.

There would thus be two classes of associations created; one for the students and younger men and for the men who are not advanced, and the other for the advanced class. As soon as the young men had progressed far enough in the profession to warrant their taking up the larger work, they would, so to speak, graduate from the young associations and attempt to secure admission into the gas institute by proving their ability to pass the necessary requirements.

ERNEST F. LLOYD:—The present scheme of independent gas associations is the outgrowth of a desire of managers operating in contiguous territory to meet at limited expense for discussion of their various interests. Each such association, desiring to increase its effectiveness through larger membership and income, has naturally gone broadcast for new members and has also drawn materially for support upon the manufacturing interests dependent upon the gas business. While it may not be said that these independent organizations waste either time or money, it can hardly be said that they can spend both to the best advantage.

An answer to a question of this character must necessarily be too brief to more than outline the method under which a single organization should operate, and for the present ignore the means whereby amalgamation may be accomplished.

A new organization would require to be on a very much more elaborate scale than any of the existing organizations, and it should be designed with special reference to best meeting the requirements of the business as we now find it in America.

First, there would be but one class of membership. We have inherited an active and associate membership from our continental cousins, who undoubtedly based their action upon the old idea that there was a sharp line of demarkation between the gas engineer as a professional man and a supplier of material as merely a tradesman, allowed in the organization only on sufferance. These conditions are not only rapidly changing abroad, but they never had any proper place in our associations. Present American conditions are, that the constructing companies generally supply the engineering element, almost to the exclusion of the professional engineer, whom we find only in the largest companies, and then more generally as a selector of designs than as an original designer. From these premises it would seem to need little argument to support the contention that it is of equal advantage for the gas manager to come in contact at the conventions with the various suppliers of material, as it is for the latter to meet at one time a number of possible purchasers. It should be further borne in mind that the legitimate cost of selling any product is a proper charge upon the business and that owing to the limited number of gas undertakings, and the special high character of the work, the expense of this is necessarily high and must ultimately be borne by the purchasers. Facility for intercourse is therefore of direct financial advantage to both. Moreover, in American practice many suppliers of material are actively interested in the management of gas properties, and the line of demarkation between active and associate membership is very irregular. Hence, such an organization would have but one class of membership.

Secondly, under the present scheme, even the smallest associations are composed of memberships from companies of widely diverse size, and consequently conditions of operating. A superintendent of an 8-inch works can at most have nothing more than an academic interest in the means to be employed in laying a 36-inch main: and the manager of a company making a million feet a day can have no more in discussing whether it is profitable to install an ammonia concentrator on two thousand tons per annum carbonized. Yet again, both have an equal practical interest in the best means of laying and protecting service pipes. That this is not a whimsical view may be attested by any keen observer at any of our present association meetings. Men operating approximately equal works naturally drift together in the discussions, and the movement of members to and from the meeting halls is almost coincident with the immediate profitableness to them of the subject in hand.

To outline its general character. Let us suppose "The American Gas Association" with permanent headquarters. Subsidiary to this central body would be, first, division chapters for the East and the West, and again subsidiary to the main body would be district chapters corresponding to the present state associations, but arranged to cover convenient territory irrespective of state lines. There would be a permanently employed staff for the transaction of all the association business. It would be presumed that the largest companies would have a meeting possibly in the fall under the direct auspices of the governing board; that the moderate sized companies would meet under the division officers, probably earlier in the year; while the district chapters would principally comprise the small companies meeting under district officers all probably in the same month. All dates of meetings would be arranged so that they would not conflict. Any member might attend all the meetings, but questions particularly pertinent to the several chapters would be classified for and particularly discussed at the different meetings. Papers as such, other than contributions to a research department, would probably be largely superseded by topics, in an elaboration of the Question Box; but all subjects, either as questions or otherwise, would be presented to the general secretary and formulated as directed by the governing board. *In this manner, the entire gas business would each year discuss all the questions brought up.* Stenographic reports would be made of all these discussions at the various meetings, and a synopsis compiled and edited by the general staff. Much detail of no permanent use could well be omitted from all existing proceedings. All would be published in a volume of "Transactions" and distributed to the entire membership.

In this manner membership in the association would become invaluable as presenting the thought of the entire gas business of the country upon all current questions. The cost of conducting such an association should be borne by the companies subscribing pro rata to output or population, with also individual memberships, and should be materially less than the sum now expended by the various associations, as at present organized, while the effectiveness of the work would be infinitely greater.

In the broader aspects of such an association, a research endowment fund, a legal department for the compilation of court decisions in the several states and abroad, with investigation of patents, etc., and new business exploitation of a uniform and concentrated character would all be made possible, while the proper influence which such a body could exert upon the technical institutions for special education, upon legislative bodies and upon public opinion would be beyond estimate.

No one even moderately well informed can view with indifference the socialistic trend of present thought regarding all quasi-public enterprise and the labor by which it must be conducted. The recent almost complete stagnation of industrial effort in New South Wales, the harassment of business in New Zealand upon the legislation there enacted as a panacea for all industrial inequalities and the continual and subtle attacks being made upon our state and national legislature for class privileges, constitute a menace of momentous import to the future welfare of our own as well as all other business. The manufacturers of the country are now fairly organized under the National Association of Manufacturers, the metal trades have a powerful organization in the National Metal Trades Association, both now vigorously and so far successfully opposing adverse national legislation.

The gas business, as great perhaps as any other one interest in the country and more keenly susceptible to attack than any other, cannot at present with its scattered organizations appear before Congress in opposition to the eight-hour law, which is at the bottom of a universal limitation upon labor; cannot appear before it in opposition to a bill which will legalize picketing and the boycott in all its worst forms; cannot bring any concentrated effort to oppose the dreamers and the politicians who are leading the public mind to a contemplation of the complete destruction of the business through municipal ownership. Surely it is high time to give thought whither we are drifting and to take counsel how these dangers may be stemmed while yet in their incipient stages.

I believe that such a concentration of energy is not only required, but that the time is rapidly approaching when the necessity for it will compel the adoption of some centralized and systematic general effort.

No. 462. On what pressure is the rating for the ordinary lava tips based? Same for Bray burners?

No. 463. Are calorimeters in general use by gas companies?

LEONARD FITZGERALD:—Calorimeters are not in general use by gas companies, the proportion being about one calorimeter to a hundred companies.

IRVIN BUTTERWORTH:—Not now, but they should be, and will be later.

F. R. PERSONS:—No, but should be.

E. M. OSBOURNE:—No, very few have them.

No. 464. What is the efficiency of a Roots exhauster?

GEO. C. HICKS, JR.:—Quoting from a catalogue now in press, under the head of slip, the following statement is made:

"Slip: This subject is hard to cover, as conditons are so variable that no rule can be given that will answer for more than one set of conditions. With clean gas, at normal temperature and pressure, not over three pounds, the slip should not be over 15 to 20 per cent. more than air, which, under these conditions, varies from 7 to 10 per cent. Therefore, 15 per cent. slip for gas would be a safe and liberal estate. With foul, hot gas, shrinkage due to temperature and specific gravity must be taken into account. The losses would also be variable as the works' conditions change. From various reports from gas companies, we find an allowance of 30 per cent. to be sufficient to cover slip and shrinkage. In some cases as low as 20 per cent. and others as high as 40 per cent. loss have been reported. Each represents some unusual condition; the 40 per cent. base being susceptible to remedy, and the 20 per cent. due to some specially favorable condition, which we believe does not usually exist under normal operating conditions. The 30 per cent. loss therefore represents a safe figure, and is the one we use in determining what size machine to recommend for a given amount of work on foul gas."

It has been our policy and general practice to provide some margin, as a general tendency is to underrate the amount of work to be done.

The question of power for running a foul gas exhauster has also to be figured on a liberal basis, as the steam pressures are often lower during a run of the water gas apparatus. Also, a machine foul with tar requires extra power to drive it. Modern progress is making big changes in power installations; conditions are becoming better known and are fast reaching a state of affairs where the variable and uncertain elements are being eradicated. As this takes place, we can make closer and better applications, for the conditions become definite.

No. 465. Of the loss of power in a Roots exhauster how much is slippage, how much is friction and how much is thermal loss due to adiabatic compression?

Geo. C. Hicks, Jr.:—The growing demand for higher pressures for distributing purposes has opened a new field for high pressure machines, and the writer takes it for granted that it is on this service Question No. 465 is based. Being a new field, we have as yet had no opportunity to make accurate tests on gas slippage, other than those stated in answer to Question No. 464.

But as far as power is concerned we have some accurate data, as gas, in this respect, would show the same as handling air. The power lost in friction averages 8 per cent. of the total work applied to the machine under full load. This friction is nearly a constant for any machine and increases but slightly from light to full load. The slip is also a constant quantity under any one pressure, the total slip per minute being the same, whether the machine runs fast or slow. In a series of tests where the air delivered was measured by meter, and also by the closed discharge method, the two series of results were so close that the closed discharge method may be accepted as an accurate method of determining the slip. It consists in closing the valve on the discharge side of a machine and then operating at such speed as will just maintain the desired pressure. The slip is then equal to the displacement of the machine per revolution, multiplied by the number of revolutions per minute to maintain this pressure.

Regarding thermal loss, I can give but little accurate data at present. Air compressed to three pounds, from a temperature of 60 degrees, would show a rise of temperature of 18 degrees. The specific heat at constant pressure is .2377, so the loss would be small in actual units of work. As an illustration, the maximum loss due to the difference between isothermal and adiabatic compression in compressing air to five pounds, would be only 4 4-10 per cent. In the rotary type of machine, the compression is adiabatic and almost instantaneous, as the gas is under normal pressure up to the time it reaches the discharge edge of the machine. The compression is done by the gas previously compressed, by its backward rush into the machine, the old and the new gas being then discharged into the pipe line.

Some of the heat of compression is absorbed by the expansion of the old gas doing this work, but as this is immediately recovered, it need not be considered. Therefore, during compression, there is practically no transfer of heat outside, and consequently the compression is adiabatic, or nearly so.

I hope in the coming year to obtain some data, and should your Association desire it, I should be pleased to present it before them.

No. 466. Does a given quantity of CO_2 depreciate the candle power more than a similar quantity of nitrogen or any other inert gas, and if so, why?

Robert Lindsey:—For equal volumes of CO_2 and nitrogen, the CO_2 will depreciate the candle power more, on account of its higher specific heat. The greater the specific heat of an inert gas, the greater will be the loss in luminosity.

E. J. Sherwood:—It does. CO_2 is a very heavy gas, and on account of its specific heat and its weight, it will absorb nearly a half more heat per given volume than nitrogen. Five cubic feet of nitrogen weigh about .46 pound, while five cubic feet of CO_2 weigh .72 pound. The specific heat of N is .244, while that of CO_2 is .2164.

$.244 \times .46 = .112$ B. T. U. and $.2164 \times .72 = .156$ B. T. U.

This shows that N absorbs .112 B. T. U. for every degree rise in temperature, while CO_2 absorbs 156 B. T. U. Then CO_2 in the presence of incandescent carbon, as in the lower part of the flame, takes up an atom of C, forming CO. This is burned later to CO_2 in the top of the flame, where the heat does not help heat up the carbon particles. Thus a loss in addition to that occasioned by the specific heat is sustained in the absorption of the heat to form CO. These losses help to lower the flame temperatures and reduce the luminosity. The CO also does not add anything to the luminosity, as it is non-luminous. The action of N is simply that of absorbing the heat of combustion.

DONALD DAVIDSON:—Co_2 depreciates to a greater extent than N due to the CO_2 furnishing O which burns up some C, $CO_2 + C = 2CO$.

J. A. SCHAEFER:—A given quantity by volume of CO_2 will depreciate the candle power more than a similar volume of nitrogen, because the specific heat of this volume of CO_2 is greater than those of the same volume of nitrogen, consequently the CO_2 in the gas takes more heat from the flame produced in the combustion of the gas than the nitrogen in it would do, and loss of heat to a flame decreases the illuminating power. But if we speak of CO_2, and nitrogen being present by weight, then the nitrogen depreciates the candle power more than the CO_2, because a given weight of nitrogen has a higher specific heat than the same weight of CO_2.

EDITOR:—The answers to this question might be put in a form to be more readily understood by the non-technical reader. The illumination from gas burned in an open tip is obtained from solid particules of carbon maintained in a state of incandescence. This carbon comes to the burner in a gaseous form in one of several hydrocarbons. The hydrocarbon is decomposed by heat and the presence of oxygen, the carbon being reduced to finely divided solid particles. They become luminous when heated to a sufficient temperature, and cease to be luminous only when reduced to oxide of carbon, either CO or CO_2.

In a Bunsen flame, oxygen is mixed with the gas previous to combustion, and it may be assumed that an intimate mixture of oxygen and the hydrocarbons has taken place before the point of combustion is reached. Upon decompositon of the hydrocarbons, the oxygen unites with the carbon freed from the hydrocarbon before the latter has reached the temperature of incandescence, and is thus reduced to a gas which does not become incandescent at as low a temperature as would the solid particle of carbon.

Air by weight contains about 33.4 per cent. of oxygen. CO_2 by weight contains about 73 per cent. of oxygen. Hence, carbonic acid gas is much richer in oxygen than air. The total amount of oxygen contained in the carbonic acid gas is not available for the depreciating process, but half of the oxygen is, and this half of the oxygen contained in CO_2 represents about 36.4 per cent. of the entire quantity of CO_2, and even considered on this basis, it is richer in oxygen than air. It seems probable to me that if CO_2 exists in the gas, one molecule of this CO_2 acts in practically the same way as would an atom of freed oxygen. One atom of carbon being supplied to one molecule of CO_2, yields two molecules of CO, rendering the atom of carbon supplied in the flame non-luminous, because it has been converted to non-luminous gas before reaching the temperature of incandescence. Hence, I assume that the presence of CO_2 in the gas depreciates it more than a similar quantity of nitrogen, and I should think the depreciation would be so noticeable that no diffeernce of opinion on this question could exist. This has always been my theory, but I have never made any attempt to determine the relative depreciating effect of nitrogen and CO_2.

No. 467. Has there been any new development in proportional meters during the last year?

No. 468. What sort of an education would be required to make a man a gas engineer?

HENRY S. WHIPPLE:—A good mathematical education, with ability to use it; a good knowledge of chemistry; a good English education. With eyes to see and ears to hear.

M. N. LATTA:—Some theoretical education in mechanical engineering a year's shop practice; a year's experience in clerical work, as in a banking, or like institution; a thorough apprenticeship in all departments of gas manufacture and distribution, including the actual manual manipulation of apparatus, and association, if possible, with at least one large and one small well-conducted works; and in this country some rudiments of the Marquis of Queensberry Rules.

E. M. OSBOURNE:—He should be a mathematician, a chemist, a draftsman, a gentleman.

No. 469. Can the steam turbine be advantageously used in a gas works?

CHAS. E. CATTELL:—The steam turbine is used by our company to advantage. Have used same for six months. No appreciable difference in fuel consumption per M.

M. N. LATTA:—We believe firmly in the turbine-blower outfit and are now placing a new one of the De Laval Sturtevant pattern.

J. D. SHATTUCK:—Steam turbines are in very successful operation in several gas works. Chester, Pa., has recently installed one which overcomes the many disadvantages of an engine, belt and shafting.

No. 470. What progress has been made on gas turbines?

J. WALLACE SHAEFFER:—There has been practically no progress made on gas turbines.

No. 471. What is the chemical agent which causes odor from burned gas?

W. S. BALDWIN:—SO_2, or sulphur dioxide, is the chemical agent that causes burned gas to smell.

No. 472. Why is a room heated with a flueless gas stove always damp?

WALTER M. BLINKS:—Caused by water vapor, one of the products of gas combustion.

DONALD DAVIDSON:—Due to H_2O due to combustion of H in the gas. $H_2 + O = H_2O$. $CH_4 + 4O = CO_2 + 2H_2O$.

E. J. SHERWOOD:—A room heated with a flueless gas stove is damp because the hydrogen in the gas burned combines with the oxygen of the atmosphere to form water vapor.

W. S. BALDWIN:—The hydrogen in the gas unites with the oxygen in the air to form H_2O which condenses to moisture.

B. F. BULLOCK:—Since the product of combustion of H—CH_4—C_2H_4 is water and this product is allowed to escape in the room, the natural consequence is that the room will be damp.

No. 473. Can any of the hydrocarbons be produced synthetically from C and H with the exception of acetylene?

Benton Dales:—Yes. See the work of Bone and Jerdan in the Journal of the Chemical Society of London, LXXI, 42, (1897); LXXIX, 1042, (1901). These authors conclude that:

1. Methane, and methane alone, is formed in small amount (about 1 per cent.) when hydrogen is passed over sugar carbon heated to about 1,200 degrees Centrigrade.

2. When the electric arc is passed between carbon electrodes in an atmosphere of hydrogen, methane, ethane and acetylene are formed, and these three finally attain a state of equilibrium with the hydrogen, the proportions of each being then about as follows: Hydrogen, 90 to 91 per cent; acetylene, 7 to 8 per cent.; methane, 1.25 per cent.; ethane, 0.75 per cent.

Donald Davidson:—CH_4 can be produced by passing electric charge through mixture of CO and H. $CO + CH = CH_4 + H_2O$.

Also by passing H_2S and CS_2 over red hot copper. $2H_2S + CS_4 + 8Cu = CH_4 + 4Cu_2S$.

W. B. Calkins:—None of the hydrocarbon series, except acetylene, have as yet been produced snythetically from the elements carbon and hydrogen alone.

No. 474. What is the relative area of the valve openings on different sized meters of the same make?

J. Chas. Andrews:—The following areas were calculated from measurements made of valve openings of meters that we had in stock. Some of the meters are not of the latest pattern; but the manufacturers' numbers are given, so that those interested may determine their age.

The area of inlet port as given means area of one port only and must be multiplied by four to get the full area of all the inlet ports. The area of exhaust port means one port only and must be multiplied by two to get the full area of exhaust ports.

Comparison of Valve Areas and Areas of Table Openings.

Meter.		Inlet Port	Exhaust Port	Table Opening
American 3 lt. No. 760,412	Area in square inches................	0.183	0.286	0.305
American 5 lt. No. A104,139	Area in square inches................	0.196	0.357	0.505
	Per cent. increase over 3 lt...........	7.1	24.8	65.6
American 10 lt. No. 555,510	Area in square inches................	0.236	0.411	0.535
	Per cent. increase over 5 lt...........	20.4	15.1	5.9
American 20 lt. No. 332,807	Area in square inches..........	0.485	1.022	0.810
	Per cent. increase over 10 lt..........	105.5	148.7	51.4
American 30 lt. No. 553,296	Area in square inches................	0.636	1.256	0.908
	Per cent. increase over 30 lt..........	31.1	22.9	12.1
45 lt.	None in stock.			
American 60 lt. No. 1,093,642	Area in square inches................	0.868	1.684	2.638
	Per cent. increase over 30 lt	35.7	31.2	190.5
American 80 lt. No. 248,161	Area in square inches................	1.188	2.381	1.783
	Per cent. increase over 60 lt..........	31.9	44.5	32.4 decrease
Maryland 3 lt. No. 331,761	Area in square inches................	0 140	0.339	0.210
Maryland 5 lt. No. 802,511	Area in square inches................	0.232	0.353	0.460
	Per cent. increase over 3 lt...........	65.7	4.1	119.0
Maryland 10 lt. No. 910,138	Area in square inches................	0.248	0.376	0.525
	Per cent. increase over 5 lt...........	6.9	6.5	14.1
Maryland 10 lt. No. 627,071	Area in square inches	0.224	0.600	0 505
	Per cent. increase over 5 lt...........	3.4 decrease	70.0	9.8
Helme & McIlhenny 3 lt. No. 149,714	Area in square inches................	0.168	0.334	0.227
Helme & McIlhenny 5 lt. No. 569,207	Area in square inches................	0.217	0.381	0.633
	Per cent. increase over 3 lt...........	16.7	14.1	178.9

No. 475. What is the relative area of valve openings in meters of the same nominal capacity, but of different makes?

J. CHAS. ANDREWS:—The following figures show the valve areas of different makes of meters compared. It has been impossible to compile a complete list as we did not have the necessary meters in stock. The figures denote square inches or fractions thereof—inlet port represents area of one opening—exhaust port represents area of one opening in valve seat:

Valve Areas of Different Makes of Meters Compared.

Size.		American Meter Co.	Maryland Meter Co.	Helene & McIlhenny.	Goodwin Gas Stove and Meter Co.	Harris, Griffin & Co.	Keystone Meter Co.
3 lt.	Meter No.	760,412	331,761	149,714	....	....	....
	Inlet Port	0.183	0.140	0.186	....	....	....
	Exhaust Port	0.286	0.339	0.334	....	....	....
	Table Opening	0.305	0.210	0.227	....	....	....
5 lt.	Meter No	A104,189	302,511	569,207	....	....	114,885
	Inlet Port	0.196	0.232	0.217	....	....	0.210
	Exhaust Port	0.357	0.353	0.381	....	....	0.371
	Table Opening	0.505	0.460	0.633	....	....	0.315
10 lt.	Meter No	555,510	910,188	....	....	170,789	....
	Inlet Port	0.236	0.248	....	....	0.309	....
	Exhaust Port	0.411	0.376	....	....	0.581	....
	Table Opening	0.535	0.525	....	....	0 640	....
20 lt.	Meter No.	302,807	....	....	47,721	....	....
	Inlet Port	0.485	....	....	0.448	....	....
	Exhaust Port	1.022	....	....	0.682	....	....
	Table Opening	0.810	....	....	0.834	....	....
30 lt.	Meter No.	552,396	....	....	60,357	....	....
	Inlet Port	0.636	....	....	0.302	....	....
	Exhaust Port	1.256	....	....	1.286	....	....
	Table Opening	0.908	....	....	0.794	....	....

No. 476. What uses of gas are there in addition to those set out in the progress report of last year?

Editor:—The only new uses I have found for gas since last year are ovens for baking rheumatic or gouty feet, legs, arms and hands; also the use of gas for keeping wood warm during a veneering process, and for seasoning fine woods.

No. 477. How can a 6-inch wall of concrete be made impervious to gas?

New York & Richmond Gas Company:—Reference: *Gas World,* May 2, 1903, page 721.

J. D. Shattuck:—Several coats of shellac will make a 6-inch concrete wall tight; or alterate washes of castile soap and alum in the proportion of three-fourths of a pound of soap to one gallon of water boiled and put on in pasty condition, hot, allowed to dry, and then one pound of alum dissolved in four gallons of water (temperature 60 degrees F.) put over the same. This process should be repeated until walls are tight. Silicia soda wash will also fill the pores.

E. M. OSBOURNE:—Would chance it. Concrete properly made will hold water, why not gas?

No. 478. Would it be feasible and advisable for gas companies to unite in the adoption of standard sizes of gas coke for domestic purposes, and for securing the manufacture of base burner stoves adapted especially to these standard sizes?

E. J. CURLEY:—Those who have trouble in disposing of it, yes. In our case we neither advertise nor solicit. The people and factories like it, want it, and come and order it. Demand is always equal to what we make.

W. HELLEN:—Yes.

B. C. COBB:—Yes.

F. W. STONE:—I believe it would be advisable and feasible for gas companies to unite in adopting standard sizes for gas coke for domestic purposes. Gas coke is an ideal fuel if burned in the proper appliance and in a suitable manner. One of the greatest drawbacks to its sale is the fact that it is at a disadvantage when used in the ordinary hard coal base burner or soft coal heater. I see no reason why manufacturers, if they have proper encouragement, could not be induced to make a stove suitable for burning gas coke. In connection with this, I would like to know if it would not be advisable for a gas company to handle such a stove, providing the local hardware dealers did not care to do so.

E. M. OSBOURNE:—We sell all our coke without such trouble. However, believe some such scheme would make it more desirable.

ORAL DISCUSSION.

MR. STONE:—Mr. President, I am rather interested in this matter. There is another question along the same line, and that is, what proportionate price should be asked for gas coke as against hard coal? There are some of us making gas coke in a section of the country where there is a good quality of soft coal at a low price. About the only market we have is as against hard coal for domestic purposes. We find that the ordinary appliances for the use of hard coal are not very well adapted for coke. I will not say that they are not a success; but the burning of the coke in them is not as much of a success as it should be. There is an enormous production of coke and we ought, it seems to me, to get rid of it in some way and get rid of it at a good price. If we could get an appliance made for the purpose of burning it the same way there is an appliance made for burning hard coal, we could get a much better price for it and we would be able to raise the price nearly to a level of the price of hard coal.

MR. BUTTERWORTH:—The American Radiator Company are making a house heating furnace, either steam or hot water, especially adapted for the consumption of gas coke. I recently had a conversation with the manager of the company. They have gotten the advantage in designing it of experience with a small furnace that has been used for some time in Germany, and I have no doubt personally but that it is about as good a furnace for burning coke as there is. I think we should all encourage their efforts in introducing that furnace. They will be very glad to have the gas companies over the country send them a list of possible users of that stove or of that furnace in their respective cities. In Detroit we are making up a list from the records of our coke solicitors of 1,000 names and addresses to send to the company, and they promise to send out literature and follow up by mail advertising. By working with the architects, builders, contractors and houseowners in our respective commmunities I think we can do ourselves a great deal of good in this direction.

No. 479. Is there a better standard for bar photometers than candles, the Methven Screen, or the Pentane Lamp?

DONALD DAVIDSON:—We have used candles and Petane lamp. Now using Hefner lamp.

No. 480. Is there any valid objection to calculating the heating power of illuminating gas from analysis as a substitute for regular calorimetrical tests?

BENTON DALES:—No, provided you have a *complete* analysis of the gas.

HOWARD E. MANN:—Have found that a calculated test and a direct test with a calorimeter will not check.

H. B. HARROP:—If the analysis is perfect the results are satisfactory, but the widely used methods of analysis fail to give a true account of the constituents of illuminating gas. The alcoholic absorption of benzene, as per Hempel, never removes all the benzene, and seldom checks; the residual benzene is then absorbed along with the illuminant gases by fuming sulphuric acid, and the B. T. U. calculation figures it as ethylene. When bromine is used, as in the Elliot scheme, to absorb the illuminant gases, certain of these heavy hydrocarbons escape absorption, and are caught in the final combustion and figure as methane. There are minor objections based on the presence of homologues of the recognized constituents of the gas.

No. 481. Is the absorption of CO by cuprous chloride solution a chemical or physical effect?

BENTON DALES:—Chemical. A crystalline compound may be obtained from the solution containing the reagent and the absorbed carbon monoxide, the formula of which is probably $2CuCl\ 2CO\ 4H_2O$. See W. A. Jones, *American Chemical Journal,* XXII, 287 (1899).

ROBERT LINDSEY:—A chemical change. See answer to Question No. 487.

WALTER M. BLINKS:—Physical.

E. J. SHERWOOD:—The absorption of CO by cuprous chloride solution is a chemical effect. The product of the absorption is $CuCl_2$, $CO + H_2O$. See Menschutken's "Analytical Chemistry."

No. 482. In the Frankland & Ward gas analysis scheme, H_2S is absorbed by a moulded ball of $Mn\ O_2$. How best can powdered $Mn\ O_2$ be moulded for this purpose?

No. 483. What is a good rule of procedure for making a quick water analysis, accurate enough for arriving at the value of boiler waters?

H. B. HARROP:—Beginning with muddy water:

Settle; decant; weigh *sediment.*

Filter; weigh *suspended matter.*

Take 250 cc. filtered water, and titrate with deci-normal HCl, using methyl orange as indicator; this gives total *alkalinity,* or *carbonates.*

To the same sample add excess NH_3, precipitating Al_2O_3, Fe_2O_3 and most of the SiO_2; filter; weigh *oxides.*

Precipitate calcium in this sample with ammonium oxolate; filter off and weigh *calcium oxide.*

To the filtrate add sodium phosphate and more ammonia; filter, ignite and weigh; caulculate *magnesia.*

To filtrate add HCl and $BaCl_2$, and weigh barium sulphate; calculate *sulphuric acid.*

On a second 250 cc. sample, determine chlorine by titrating with standarized silver nitrate, using potassium chromate as indicator.

The probable combinations may be worked out thus: Calculate all magnesium as carbonate (if excess of magnesium remains calculate as sulphate); combine excess of CO_2 with calcium (if further excess of CO_2 remains combine with sodium); calculate remaining calcium as sulphate, remaining sulphuric acid with sodium, and chlorine with sodium. This is applicable to boiler waters and gives reasonable accuracy. It admits of several modifications.

The larger railroads report analyses more or less after this fashion.

Oxides Calcium carbonate Calcium sulphate Magnesium carbonate Magnesium sulphate	total incrusting solids.
Magnesium chloride Alkali carbonate Alkali sulphate Alkali chloride	total non-incrusting solids.

All results in grains per gallon.

No. 484. What modifications of ordinary water analysis are essential to determine the contents of the water in a station meter?

H. B. Harrop:—No one is justified in attempting this unless he understands exactly what he is doing.

No. 485. What is the average drop in candle power between the works and the consumer in zero weather?

E. M. Osbourne:—Much depends on how thoroughly gas is fixed when it leaves the plant, and length of time stored before started on trip to consumer. Gas well fixed and held in storage six or eight hours will not fall off more than 2 c. p. If it passes to consumer direct from plant and is not thoroughly fixed, it will fall off 4 to 6 c. p.

No. 486. What is the best kind of gas to use in large gas engines?

J. Wallace Shaeffer:—The best kind of gas to use in large gas engines is the one with the least amount of hydrogen and the greatest amount of CO and hydrocarbons of course, so that the blast furnace gas is now the most economical gas to use in large engines. On account of the relatively low percentage of hydrogen in this gas, compression can be carried on to a higher degree without danger of premature explosion.

No. 487. In using the Orsat apparatus, is there any chemical reaction between potassium hydroxide and carbon dioxide; pyrogallic acid and oxygen; cuprous chloride and carbon monoxide? If so, give the reactions.

Benton Dales:—Chemical in each case. $2KOH + CO_2 = K_2CO_3 + H_2O$. Under certain conditions potassium bicarbonate ($KHCO_3$) may be formed.

The alkaline pyrogallate absorbs oxygen, decomposing as a result into potassium carbonate, potassium acetate and brown colored substances of unknown composition. (Richter's Organic Chemistry.)

Cuprous chloride and carbon monoxide add themselves together. (See answer to 481.)

Robert Lindsey:—The chemical reaction between potassium hydroxide and carbon dioxide is

$$2KOH + CO_2 = K_2CO_3 + H_2O.$$

The ultimate products of combination resulting in the chemical action between pyrogallol and oxygen are oxalic acid and acetic acid.

Cuprous chloride and carbon monoxide combine to form $CO \cdot Cu_2Cl_2(H_2O)_2$, an unstable compound decomposed by water.

E. J. Sherwood:—The absorption of CO_2 by KOH is a chemical action. KOH acts on CO_2 as follows:

$2KOH + CO_2 = K_2CO_3 + H_2O$. See Remsen's "Inorganic Chemistry."

The absorption of oxygen by pyrogallic acid is a chemical reaction. The solution turns brown and black and then contains CO_2 and acetic acid and small quantities of CO are given off. This is taken from Roscoe & Schorlemmer—"Treatise on Chemistry."

The absorption of CO by cuprous chloride solution is a chemical effect. The product of the absorption is Cu_2Cl_2, $CO + (H_2O)_2$. See Menschutken's "Analytical Chemistry."

No. 488. What are the theoretical flame temperatures, with correct amount of air, and with 10 per cent. excess of air, for H_2, CO, CH_4 and C_2H_4?

E. J. SHERWOOD:—The theoretical flame temperature is found by dividing the net heat of combustion by the amount of heat absorbed by degree by the products of combustion.

The specific heats taken from Regnault are as follows:

CO_2	.2164
N	.244
Water vapor	.475
O	.2182

H burns on the addition of O to water vapor, requiring eight pounds of O to one of H and giving off nine pounds of water vapor.

The calculations are as follows:

$$.475 \times 9 = 10.736 \text{ B. T. U.}$$

The heats of combustion are as follows:

H	61,500	These are gross values.
CO	4,478	
CH_4	24,020	
C_2H_4	21,500	

The latent heat of the water vapor is to be deducted from the gross heat.

$965.2 \times 9 = 8686.8$ B. T. U.

$61500 - 8687 = 52,813$ B. T. U.

$52813 \div 10736 = 4919°$ above the temperature of the combustibles. Add 60° and the answer is 4979° as the flame temperature for hydrogen with the correct amount of air.

In similar manner the other temperatures are found. The results are shown in the tables below:

Flame temperature.	With correct amount of air.	With 10% excess.
H_2	4979° F.	4582°
CO	5651° F.	5206°
CH_4	5968° F.	4585°
C_2H_4	5046° F.	4649°

No. 489. What is the difference between the specific heat of a gas at constant pressure and at constant volume?

Benton Dales:—It takes in round numbers 2 calories, or about 7.9 B. T. U.'s, more to raise one gram molecular weight of any gas (the molecular weight of the gas in grams) through 1° Centigrade at constant pressure than at constant volume. For simple gases and for those gaseous compounds formed from the simple gases without condensation

$$\frac{\text{specific heat at constant pressure}}{\text{specific heat at constant volume}}=1.41$$

The values of the ratio for other gases may be found by reference to either of the books mentioned in the answer to 451.

Robert Lindsey:—When a gas expands heat becomes latent (insensible to the thermometer). The amount of heat necessary to raise a gas to any given temperature increases the more it is allowed to expand. The quality of heat which the unit mass of a gas requires to raise its temperature one degree without its volume undergoing any change (the pressure will therefore be increased as steam in a boiler) is called the specific heat of a gas at constant volume. The amount of heat necessary to raise the unit mass of a gas one degree, it being at the same time allowed to expand to such an extent that the pressure to which it is exposed remains the same(as gas in a holder) is called the specific heat at constant pressure.

From the foregoing it will be seen that the specific heat of a gas at constant pressure must be greater than at constant volume.

Walter M. Blinks:—Specific heat of a gas is greater at constant pressure than constant volume, as a gas in expanding at constant pressure does extra work against atmospheric or other resistance and requires more heat for the same rise in temperature.

R. C. Congdon:—The amount of heat measured in heat units which must be imparted in order to raise one kilogram weight of any body one degree in temperature when expansion cannot take place, is called the *"specific heat for constant volume."*

We call, on the other hand, that amount of heat which is necessary to raise the same unit weight one kilogram of any body one degree in temperature when the body is allowed to expand under the constant pressure of the atmosphere, *"the specific heat for constant pressure."*

It must evidently be greater than the first, because heat is required to perform the disgregation work and outer work which take place in the second case.

FRED HAUENSTEIN:—Ordinarily we might say, the specific heat of a body is the ratio, compared with an equal weight of water, of the amount of heat required to raise its temperature one degree. Thus, if we say that the specific heat of a substance is .5, we mean that only one-half as much heat is required to raise its temperature through one degree as would be required for an equal weight of water. Water is usually taken as the standard for comparison, but in respect to gases it is sometimes more convenient to refer them to an equal volume of air.

Since the application of heat to a gaseous body may also cause a variation in its volume or pressure as well as temperature, we have then the specific heat at constant pressure, and the specific heat at constant volume. The specific heat at constant pressure may be defined as the ratio of the quantity of heat required to raise the temperature of a unit volume of the gas maintained at a constant pressure, compared with that required for a unit volume of air under the same conditions. Similarly, the specific heat at constant volume requires that the volume be kept constant during the operations. As a matter of fact, the specific heat at constant pressure is the greater of the two. For air it is 1.41 times as much as the specific heat at constant volume.

H. H. HIMSWORTH:—The specific heat of a gas is less at constant volume than at constant pressure. The heat added to a quantity of gas at constant volume is *all* used in actually increasing the temperature, while under the condition of constant pressure some of the active heat applied is neutralized or rendered latent in effecting the change of volume. Hence, the gas at constant pressure requires the addition of more heat for a corresponding increase of temperature than that at constant volume.

No. 490. Gas which leaves the holder saturated with moisture loses a large percentage of this vapor as it travels, and owing to the diminution of the vapor tension, a cubic foot should contain a greater mass of combustible matter in outlying districts than at the works. Is this correct?

DONALD DAVIDSON:—The condensation of moisture would increase the mass of combustible matter per cubic foot, but this may be counterbalanced by condensation of hydrocarbons of high specific gravity, which usually takes place along with the moisture.

No. 491. Is there any direct method of converting sulphocyanides into cyanides except by the action of nitric acid?

BENTON DALES:—A method for the direct production of cyanides from sulphocyanates has been patented in England by D. J. Playfair (English patent 7764, May 19, 1890). He removes the sulphur from the sulphocyanate by fusing the latter with metallic lead or zinc. See the *Journal of the Society of Chemical Industry* X, 547 (1891); XI, 14 (1892). Sulphur may be removed from sulphocyanates by oxidizing agents other than nitric acid, as, for instance, potassium permanganate or hydrogen peroxide in acid solution, but in these cases, as with nitric acid, the hydrocyanic acid must be obtained by distillation.

No. 492. Will water absorb heat as readily by contact with hot air as with iron, the same amount of heat being available?

No. 493. Can iron be economically welded with $1.00 gas?

J. H. HAGERTY:—No.

No. 494. Is more heat obtained from gas when an air blast is used, and what occasions the difference in results obtained?

J. H. HAGERTY:—A higher flame temperature is obtained, but no more heat per unit of gas consumed.

PHILO JONES:—The Troy Laundry Machinery Co. tells me that by using an air blast in connection with their iron heaters, the gas consumption is reduced one-half from that of atmospheric burners.

MR. MCDONALD:—Mr. President, I think this Question Box and the responses which have been collected by the editor, together with his comments, is one of the most valuable contributions to gas literature that we have yet received. I therefore move that a hearty vote of thanks be extended to the editor and that that vote be taken by rising.

The above motion was then duly seconded and unanimously adopted by a rising vote.

PRESIDENT MCILHENNY:—This motion has been adopted unanimously and it affords me very great pleasure, genuine and sincere, to notify Mr. Doherty of the adoption of the motion and to say that he has conferred an inestimable service upon the Ohio Gas Light Association and the gas fraternity at large. It is a work that will live, and it will be of great help to the people who want help. I do not know of anything that a man can do which is more laudable than to give help where it is needed.

MR. STONE:—As I understand, the motion carries with it a request for Mr. Doherty to continue in the work.

PRESIDENT MCILHENNY:—We will not request it; we will simply have it that way. We will not permit him to discontinue.

MR. DOHERTY:—Mr. President and Gentlemen: I want to acknowledge the vote of thanks you have given me and to say that your hearty support is very greatly appreciated, because the work and labor of this Question Box is the biggest undertaking I have ever encountered. If I continue it for another year I want to make a request, and I want every man to feel that he is being addressed personally, to contribute to it the coming year and to induce his associates in business to do likewise. It is very trying to endeavor to get replies and assistance from fourteen or fifteen hundred men who are only too apt to say: "This is a pretty good thing, but I am busy and haven't got time to fool with it." The time they would have to occupy in "fooling with it" would be very little as compared to the work which devolves upon the editor in collating these questions and answers.

MR. SCHWARM:—I would like to make a motion, Mr. President, that the Ohio Gas Light Association request Mr. Doherty to continue his work for another year.

MR. MCDONALD:—I second the motion and suggest that the vote be taken by rising.

The above motion was unanimously adopted by a rising vote.

MR. DOHERTY:—I expect to continue it, Gentlemen, and I will certainly do so unless some grave reason comes up to prevent. I now have one man broken in who has been of great help to me, and that is J. Charles Andrews. His assistance has been most valuable to me, and if anything should transpire which would prevent me from continuing the work he is in a position where he could take it up.

DR. H. B. HARROP then submitted the following:

MOTION TO CONSTITUTE A COMMITTEE OF REVISION.

GENTLEMEN:—The editor has effectually disposed of the criticisms aimed at the Question Box, with one exception. The answers elicited by the question list are not always to be depended on in point of accuracy, and in many cases they are not so full and complete as might be wished. This is a defect; and it is not clear just how it can be remedied. I am not at all certain that it should be remedied. A genuine remedy would involve radical changes in the Question Box and to be effective might even have to be carried to the point where the Question Box would lose its very identity. The department has succeeded to date in bringing together a more diverse range of gas lore than any association has ever seen, and it has served the double purpose of arousing in gas men a readiness to impart information and a willingness to ask help of others. Comparing this year's issue with the preceding one, a marked improvement is noticed in range, bulk, and quality of the matter collected, and there is no good reason why each succeeding year should not show a similar marked improvement over its immediate predecessor. If this is to be continued, the fund of information that will eventually be collected in classified form is simply incalculable. The Question Box as it stands represents one of the most important developments in gas literature in recent years; if we can remove the element of unreliability, and that without affecting the present policy of this department, we can produce in a very short time an encyclopedic work that will surpass any single venture ever attempted for the advancement of the industry.

The plan which I am about to propose will give us a work of reference of unquestionable reliability, perfecting the original object of the department, and without limiting the sphere of activity of the Question Box. I think it may be assumed that the present policy of the Question Box is satisfactory and that it will profit us nothing to tamper with it. What we must do is to turn our attention to the accumulated fund of information, growing in bulk and diversity with each yearly increment—the past editions, which have become a part of the proceedings of the Association—and to protect the man who turns to this collection for positive information or advice; that is to say, after each yearly harvest of contributions has been published as received, the material so acquired must be revised and digested, and merged into a compendium that will represent everything worth keeping received up to that time.

No one man could do this. No gas man can be expected to know every branch of the industry, and moreover the active gas man is too busy making his living or a name for himself. The proposal to which I am leading may be best explained by an illustration. The American Medical Association and the American Pharmaceutical Association each appoint periodically a number of their ablest members to decide on the standards common to their two professions. These men jointly agree on the multifarious subjects brought before them, calling to their aid the best scientific and technical skill available, causing research work to be done wherever necessary, and publishing the results of their labors in the form of a standard book of reference, the United States Pharmacopoeia. The physician can prescribe an official preparation, the pharmacist knows what the physician means, and the physician knows that the pharmacist knows. The existence of this standard does not tie the hands of either; preparations not included among the standards may be prescribed and compounded; but if an official formula is specified there can be no quibble as to interpretation or characteristics. Every state in the Union that protects its citizens with a pure food law names the Pharmacopoeia as the ultimate criterion and the courts recognize its supremacy. Confusion arising from a lack of uniformity is impossible. Another single instance. Many of the products defined in the Pharmacopoeia are c. p. reagents used in the analytical laboratory, and of these a goodly proportion are suited to the most rigid analytical work. The chemist can order a "U. S. P." reagent knowing exactly what that reagent will be, and by turning to his Pharmacopoeia, he can find the several tests which the reagent must pass to prove that it is "U. S. P."

This Association numbers among its members a large percentage of the foremost gas engineers and managers in the country, and it is growng rapidly and persistently. The enthusiasm and hard work which have marked this present convention as the most fruitful held in America up to this time prove that the Association is amply capable of undertaking the task mapped out in the motion I shall read shortly. The Committee of Revision should be large enough to be representative but not so large as to be unwieldly. It should include a quota of younger men still in the first flush of youth and energy on whom the actual work of revision with its accompanying labors of research will devolve, as well as more mature members who have passed on to face large engineering and managerial problems. Some of these latter may be reluctant to join in this work, knowing that their time is already fully occupied, but for the sake of the work and the development of the industry we must have them; let it be understood that all that will be asked of them is to act in an advisory capacity where problems arise that require the ripest judgment.

The Committee should never at any time be concerned with the forthcoming issue of the Question Box. But the past issues should be given a thorough revision, removing the element of unreliability and supplementing wherever possible with data and further reference. The Committee should correspond with the various contributors to the Question Box, asking them to co-operate in the revision of their answers. The contributor probably wrote his answer under stress of other work; he has learned more about his topic since then; he has given it more thought and perhaps has experimented further; he may be able to give figures that will bear out and render more valuable what was in the first instance a bare statement. Where topics have only been partly answered and no more information is available they can be referred back for further investigation.

Last year a proposition to organize a Research Section was broached. The President's address this year recommended a Bureau of Information. There is no good reason why these and other departments, if organized, should not work harmoniously with the Committee of Revision. The report of the Committee will grow year by year as material is drawn from new issues of the Question Box, and ultimately it may even be found desirable to include items from the Wrinkle Department and conclusions from the papers read before the Association, and the report will evolve into a compendium of ever increasing value. Be sure that all this will not tend to fossilize the common practice, but will develop the production of gas into a truly technical industry.

Now, Mr. President, in accordance with the argument just made, I move that the Ohio Gas Light Association constitute a Committee of Revision with powers and duties as hereafter described. The Committee shall consist of a chairman and from nine to nineteen associates, who shall be chosen with a view to representing as nearly as possible the best technical material within the compass of our membership. The chairman, appointed by the Association at this meeting, shall select, in conjunction with the general officers, associates from engineers and other active workers in the profession who are known to be experts or authorities in construction, plant operation, distribution, chemical and physical research, manufacture of coal-gas, of water-gas, of tar, ammonia, and other residuals, new business, managerial direction, and accounting and record, and such selection shall constitute an appointment by the Association. The Committee as thus organized shall be permanent, the members thereof serving one year, or until their successors are chosen.

During the ensuing year it will be the duty of the Committee of Revision (by correspondence or otherwise) to digest, edit and annotate the contents of the Question Box for 1903 and 1904; revising the material as may seem necessary, stamping such matter as rests upon unquestioned scientific fact or unimpeachable experimental data with the seal of authority, and, on the other hand, where difference of opinion is widespread, calling attention to these differences, and reconciling, emphasizing, or pointing out the necessity for further inquiry, as each case may demand.

The Committee shall be entitled to legitimate expenses for stationery, postage, printing, etc., under the direction of the general officers of the Association and the usual restrictions applying to Committees.

PRESIDENT McILHENNY:—This is a new subject and simply indicates that the Ohio Association has within it those whose minds are working and who are endeavoring to do somtehing for the betterment of the business in which we are all interested.

The above motion was then duly seconded and unanimously adopted.

The President then announced that Mr. William McDonald desired to address the Association briefly in reference to the coming

GAS CONGRESS.

MR. McDONALD:—Mr. President, I do not know that I desire to make any extended remarks about the Congress. I was in hopes that the Congress Committee would be able to have a meeting while attending the convention of the Ohio Gas Light Association; but owing to the fact that some of the members could not be here we have been unable to get together. We hope, however, that the Ohio Association will take some active interest in the Congress to be held in St. Louis in June, beginning, I think, on the 13th and lasting three days. I feel sure that I express the wish of the Committee of which I am a member when I say that it is their hope that any of the members of the Ohio Association who go to the meeting, either of the Western Association or the Congress, and especially the Congress, will come as accredited delegates from the Association if they so choose. Of course many gas men are members of different associations and they can choose, in attending the Congress, which association they will come as a delegate from. It is the desire that the officers of the various associations shall come in the same way. It is also desired, if the other associations could see their way clear, that they would make some appropriation towards defraying the expense of the Congress. In the letters that have been written on this subject it has been said that there was no desire whatever on the part of the Congress Committee to ask any association to do anything that they did not feel like doing, but any moderate sum that the association might feel willing to contribute towards the expense of the Congress will be duly appreciated. It will also be high appreciated if the associations will send some of its members as delegates to that Congress. I trust before this Asociation adjourns that it will take such action as in its wisdom seems best towards encouraging the work of the Congress and helping to make it a success.

PRESIDENT McILHENNY:—I would say to Mr. McDonald that the matter has already been brought officially to the attention of the Association through correspondence with the request that a Committee be appointed from this Association to act in conjunction with a general committee. The matter has been arranged to be brought up tomorrow, so that no doubt the action will be taken then and the committee appointed which will have power to act on behalf of the Ohio Association in any matters which may affect the Ohio Association.

MR. McDONALD:—That being the case, Mr. President, I desire to say a word further. I hope that each member of the Ohio Association will realize that the Congress is an event the like of which has never taken place in the United States and it may be a very great many years before anything of the kind will be undertaken again. It would be a very profitable thing for as many of the gas people of the country as possible to get together at that Congress, and I urge upon the members of the Ohio Association, or as many of them as can, to come to that Congress.

PRESIDENT McILHENNY:—The invitation is appreciated, and I feel sure that the Ohio Association will do all it can to co-operate in securing a successful Congress. The Gas Congress, no doubt, will be a notable event and it will be made notable by the participation upon the part of the members of the various associations throughout the country.

On motion, duly seconded and carried, the meeting then adjourned until March 18th, 1904, at 9:30 o'clock A. M.

THIRD DAY—MORNING SESSION.

The Association met at 9:30 A. M.

PRESIDENT McILHENNY:—I will first ask Mr. W. H. Barthold to read to us the

REPORT OF COMMITTEE ON UNIFORM SYSTEM OF MAPPING MAINS.

To the Ohio Gas Light Association:

GENTLEMEN:—The great amount of detail connected with the proper mapping of street mains, gives rise to a large difference of opinions as to just how this work should be done. To describe the various systems is a large undertaking. We have had this matter treated in papers before the Gas Associations until we have become familiar with some of them. However, we cling to our own ideas and are reluctant to give them up for any particular scheme.

You have before you, copies of the paper read by John Hellen, of Grand Rapids, Michigan, at the eleventh annual meeting of the Michigan Gas Association, in which he presents the system of recording and mapping mains as followed by his Company. It consists of two blue print maps showing the whole territory to a scale of 800 feet to the inch. On one map are all of the mains, and on the other are the 6-inch mains and larger. For recording details, are the forms as explained in his paper and insurance map.

It is better for the large maps that white prints with blue lines be used. One for all mains, one for 6-inch mains and larger, one for drips, giving their location and number, one for valves, and one showing the paved streets.

You have before you, two white print maps showing the mains. These are quite clear and when used in connection with the insurance maps, give an excellent record. On these the extensions can be placed from time to time.

The drip map is a plain white print upon which the drips are located in red dots about three-thirty-seconds of an inch in diameter and then numbered. These numbers refer to the drip record and insurance maps.

When there are a large number of valves a separate white print should be used, upon which the valves are located with a red circle, crossed. In most cases, there are no valves and a valve map is not nececsary.

The paving map is another plain print upon which are shown the paved streets, the various kinds of paving designated as follows:

Cedar on board	Buff.
Cedar on concrete	Dark Brown.
Asphalt	Green.
Brick	Red.
Cobble Stone	Yellow.
Macadam	Blue.

For recording details an insurance map is used. The scale is 50 feet to the inch. It consists of separate sheets bound in book form, each sheet covering several squares. They show all buildings. Arrangements can be made with the publishers to keep them up to date. A very fine feature of this way is, that all services can be placed upon it, showing where they enter the customer's property and buildings.

Where insurance maps cannot be obtained, divide the city up into sections, making maps of convenient size with a scale of 50 feet to the inch. You will then have all that the insurance map gives except the buildings.

On these maps should be located every main in the street, giving the distance from *property* line and the position of all fittings and drips. The mains should be indicated with dark blue lines, and the sizes marked.

On the large white print maps the 6-inch and larger should be made with heavy lines. Do not use colors—they fade and become hard to distinguish. Besides, colors do not appeal to every one. However, if too many colors are not used, a good map can be made. For instance, the 3-inch and 4-inch in orange, the 6-inch in red, and the 8-inch and larger in black, give a clear view of the mains. The large feeders stand out very prominently.

The system of dots and dashes is not good. The best idea in this regard is to have three thicknesses of lines, the 2-inch, 3-inch and 4-inch in light lines; the 6-inch, 8-inch and 10-inch medium lines, and the 12-inch, 16-inch and 20-inch heavy lines. The 2-inch, 6-inch and 12-inch in full lines, the 3-inch, 8-inch and 16-inch in dot and dash lines and the 4-inch, 10-inch and 20-inch in dotted lines, thus

2-inch ————————	6-inch ————————	12-inch ————————
3-inch —— — ———	8-inch —— — ———	16-inch —— — ———
4-inch - - - - - - - - -	10-inch - - - - - - - - -	20-inch - - - - - - - - -

Your attention is called to a white print map of the center lines of the streets. The names of the streets are placed as much as possible at the ends of the street to keep the map clear. On this can be shown the mains, placing them on either side of the center lines according to the side of the street on which the main is laid. This gives a very clear map to work on and has been suggested for use in laying out a new main system or bettering an old one. For this purpose, it is quite valuable.

Your Committee recommends the system as given in Mr. Hellen's paper, with the addition of the white print maps as described above. Of course, what will do for a small company will not do for a large one and vice versa. A large company can and should have a more elaborate record than a small one. Conditions govern the system to use. The one as outlined, however, can be used by the smallest as well as the largest company, except that the small company must get a substitute for the insurance map.

Respectfully submitted, W. H. BARTHOLD.

DISCUSSION.

PRESIDENT McILHENNY:—This is a very valuable contribution, and something that will be appreciated, not only by the members of the Ohio Association, but by the fraternity at large. There has been a very great lack of available information as to the best way to map the mains in a town. This gives us certainly a very comprehensive statement of the situation, and I am sure it will be a great help to all of us. Are there any comments or any questions to be asked? It is a subject which will develop more as we look over Mr. Barthold's report later on. We are certainly indebted to Mr. Barthold for his most excellent work.

It was then moved, seconded and carried that the report of the Committee be received and ordered spread upon the minutes, and that a vote of thanks be extended to Mr. Barthold for the report just submitted.

PRESIDENT McILHENNY:—We will next take up among the short topics a paper prepared by F. W. Frueauff on the subpect, "District Collection of Gas Bills." We are all disappointed in the fact that Mr. Frueauff could not be in attendance at this meeting and participate in our discussions. I will call on Mr. Butterworth to read Mr. Frueauff's contribution.

Mr. Butterworth then read the following paper:

THE DISTRICT COLLECTION OF BILLS.

F. W. FRUEAUFF.

The plan of reading meters and billing and collecting accounts at three periods during each month was commenced in Denver in November, 1902, and we have therefore had the experience of one year to reach our conclusions.

The principal reasons which caused us to change from the former plan of reading all meters at the end of each month, rendering bills on the 1st, and allowing discounts to and including the 10th, notifying delinquents on the 15th, and shutting off for non-payment by the 20th were as follows:

(1) Our inability to get reliable meter readers on all routes each month. We were unable to take enough men away from their regular monthly duties to gather an efficient corps of readers, consequently we had to employ extra men to fill out. Some would be found quite reliable, some fairly good readers, and nearly every month one or two would make a signal failure of their reading, resulting in much of the work having to be gone over by the other men to verify questionable readings. Many meters would be skipped, marked "can't find," and many bills would be sent out which brought the consumer back to the office asking for a re-reading, and often mistakes were found in their readings as billed, either in the reading for that month or showing the meter had been under-read the previous month. The public complained that new men came to read the meters each month and they had no confidence in their ability to read correctly. Much time would be lost by new readers in explaining who they were and why they called and in finding the meters on premises they had not visited before.

(2) The marking out and sending of all bills at one time made a rush of work in the office that seriously interfered with careful and accurate work, making more work to be done in a few days' time than could properly be done, and resulting in slow days in the middle of the month when work could not be found to keep all help busy.

(3) The majority of our customers came to the office on the 8th, 9th and 10th of the month; many to pay without comment or protest, some to comment or have explanation made and some to complain of their bill. It was impossible to give each one the courteous treatment they were entitled to receive. It was hard

to get accurate tellers to receive and receipt for payments. It necessitated extra help in explaining away complaints, who could not be as familiar with conditions and reasons as the regular complaint clerk and who would not give them as much attention as their case might need.

(4) The crowds at the office on the last discount days were so great as to make it hard for them to get in line and compelled them to wait unnecessarily long for an opportunity to transact their business.

(5) Our salesmen on the floor could not give sufficient time to each possible purchaser who would look at appliances on exhibition as they passed in or out of the office. This we felt resulted in the loss of much possible new business, as a clever salesman is often able to convince them that they are in need of the appliances they are casually examining.

One month before the change was made we attached a slip to each bill sent out advising our consumers that we had decided to make a change in our plan of billing in order to insure them more satisfactory attention at our office, and advising them of the date when their next bill would be rendered, when payable and the period of time it would cover; this last point being to forestall any complaints of high bills which would be traceable to the long time covered in the bill.

The next month we arranged a force of men who would read meters, deliver bills, deliver receipted bills, deliver delinquent notices and shut off delinquents, and by arranging a schedule their time is occupied throughout the entire month.

To make up our report of earnings for the first month under the new plan we had to make an estimate of the revenue in the second and third districts, as no readings were taken here until the second month, then we allowed for the amount chargeable against the arbitrary estimate for the first month and applied the balance to the month of December revnue.

We feel that the new plan has been an improvement in every respect.

First.—We are able to get all meters read promptly and accurately. During the past three months we have read an average of 32,000 meters per month, and the number of mistakes discovered averaged 14 per month; there were 12 men reading, or practically but one mistake per man per month, and one mistake for every 2,285 meters read. With the old plan our mistakes have run as high as 250 in one month, and many meters were re-read owing to our lack of confidence in the man reading, which resulted in extra expense in reading and delay in sending of bills.

Second.—Our office work is now so arranged that we have done away with the rush and dull periods.

One teller and helper are on their work constantly, and require no assistance except on the last discount day in each district, when one other man helps for a portion of the day.

The bookkeepers are now working in three sections. Those in the first district foot their revenue the first two days of the month, post cash, orders, etc., until the 12th, take off delinquent lists and balance sheet on the 13th and 14th, write orders and shut off lists until the 20th, post orders and arrange bills for next month until the 25th, and make bills the last four days of each month. Each bookkeeper has about 3,300 meters on his ledger, including both gas and electric accounts in his district, so that they carry two balances for each book. A helper works with the bookkeeper in the making of bills and gives a third of his time to each district, as the time for making bills comes around.

The same plan as above outlined is pursued by the bookkeepers in the second and third districts, except that they send out their bills on the 11th to 21st instead of the first of the month, and follow the same procedure as in the first district, but being 10 or 20 days behind.

So far as cost of labor goes, we find the cost of reading meters and delivery of bills has been reduced about 17 per cent. The cost of bookkeeping and billing is practically the same as with the old method, but we are now getting additional data and information from our bookkeepers, such as sales of current by circuits at various rates, etc., without increased cost. The cost of tellers is reduced by the new plan, both in amount paid for wages and in the saving of the new plan, both in amount paid for wages and in the saving resulting from fewer shortages in cash, which frequently occurred with new and inexperienced men at the pay window.

Third.—The public are now taken care of promptly, both at the pay window and on complaints, and the salesmen on the floor have ample time to give to customers who are looking around as they pass in and out of the office.

As the company's business grows, we will have to make other districts, and eventually will have a list discount day on each week day in the month. Our meter readers will then read constantly, others will deliver bills constantly, etc. We will then have a uniform number of consumers in the office each day.

PRESIDENT McILHENNY:—This is certainly a very comprehensive and excellent discussion on the subject. Are there any comments to be made upon the paper of Mr. Frueauff or any questions to be asked?

It was then moved, seconded and carried that a vote of thanks be extended to Mr. Frueauff for his most excellent contribution.

PRESIDENT McILHENNY:—We will next hear the report of the Committee on Standard Sizes of Coke, of which C. W. Andrews is chairman. Mr. Andrews was expected at the meeting, but has been unavoidably detained. I will call on Mr. Stone to read his report.

F. W. Stone then read for C. W. Andrews the following

REPORT OF COMMITTEE ON STANDARD SIZES OF COKE.

To the Ohio Gas Light Association:

GENTLEMEN:—Your Committee on Standard Sizes for Coke begs leave to submit the following report:

The question of standard sizes for coke is one which involves quite a number of features, differing in various localities and I feel that the simplest way to bring this before your Association is to give you the size of the screens which are most generally used, rather than simply the size of coke. The screens which are erected in many of the larger gas works are revolving screens covered with plate iron, punched with openings of whatever sizes might be desired. These screens usually divide the coke as follows:

First opening 0.375 to 0.5 inch diameter. This section takes out the breeze. The second section which has holes varying from 0.875 to 1 inch in diameter removes the pea coke. In the final section the holes are usually from 1.875 to 2 inches in diameter, thus separating the nut. That which goes through the end of the screen remains as lump. In this method of screening gas-house coke, about 0.33 is usually removed in the smaller sizes, while 0.66 or even 0.75 goes through as lump.

If a larger proportion of crushed coke is desired, a crusher is installed, whose opening is about 3 to 3.5 inches. When its product is run through a screen of the above size the ordinary egg coke is produced. This coke, therefore, has passed through the 3.5 inch opening of the crushed and over the 1.5 inch opening, or the last section of the screen.

Should ordinary wire mesh screen be used instead of punched screens, the size of mesh is reduced somewhat. These wire screens vary from 0.375 to 0.5 inch, from 0.75 to 1 inch, and from 1.5 to 1.75 inch respectively.

Another design of screen is that in which plates are used, punched with oval or slotted holes. These holes are usually from 0.44 to 1.5 inch by 1.5 inch, 0.75 inch by 2 inch and 1.5 inch by 3 inches.

The result of the use of the various screens has been to establish the three grades of the following standard sizes: Pea over 0.5 inch and through a 1-inch; nut over a 1-inch and through a 1.5 to 2-inch, depending on the grade of coke desired, it varying in various localities, and finally, egg coke which goes over a 1.5 to 2-inch and through 3 to 3.5 inches.

Respectfully submitted, C. W. ANDREWS,
Committee.

It was then moved, duly seconded and carried that the report of the Committee as submitted by C. W. Andrews be received and ordered spread upon the minutes of the Association, and that a hearty vote of thanks be extended to the chairman for the very valuable suggestions contained therein.

PRESIDENT McILHENNY:—If Mr. Steinwedell is present, we will hear the report of the Committee on Next Place of Meeting.

MR. W. E. STEINWEDELL, Cleveland, Ohio:—I would like to say as a preface to the report of the Committee that the Committee tried to get an expression of opinion from the various members present as to the place where the members would prefer to have the next meeting held. The Association has become so large that it seems there are only three cities in the state having hotel accommodations sufficient to accommodate the membership. Those cities are Cleveland, Cincinnati and Columbus. As we met at Cincinnati last year and met at Columbus the year before there seemed to be quite a sentiment for going out of the state if we did not go too far. As we have a great many new members recently admitted and these members will, a great many of them, attend next year's meeting, we thought we ought to be housed pretty well, and at the same time be conveniently located so that every one could attend.

In selecting the place we have selected, we also took into consideration the matter of railroad facilities. With these remarks, I will submit the following

REPORT OF COMMITTEE ON PLACE OF NEXT MEETING.

To the Ohio Gas Light Association:

GENTLEMEN:—Your Committee on Place of Next Meeting begs to report that it recommends Pittsburg, Pa., as the most suitable city.

Respectfully submitted,

W. E. STEINWEDELL,
J. J. KNIGHT,
Committee.

MR. BUTTERWORTH:—I move that the report of the Committee be adopted and that Pittsburg, Pa., be selected as the next place of meeting.

The above motion being duly seconded was then unanimously adopted.

PRESIDENT McILHENNY:—I will now ask Mr. Butterworth to read the report of the Committee on President's Address.

Mr. Butterworth then submitted the following:

REPORT OF COMMITTEE ON PRESIDENT'S ADDRESS.

To the Ohio Gas Light Association:

GENTLEMEN:—Your Committee on President's Address desires to commend it for its dignity and optimism, and for expressing much of value and importance in comparatively few words, especially in the way of encouragement and helpfulness for the future of our Association and of the gas business in general.

The suggestion as to the possibilities for adding greatly to the profits of gas companies by the development of the use of gas for industrial purposes we regard as extremely timely and important, and we recommend that all gas managers give this branch of our business more attention than heretofore, and especially that earnest thought be given to the devising of some equitable system of charging for gas that will enable gas companies to secure a larger amount of this most profitable class of business than our present methods of charging will permit.

We also recommend that our Association carry out our President's suggestion as to the establishment of a Bureau of Information for the benefit of our members, and that the Executive Committee proceed at once in accordance therewith, appointing a proper chief of such bureau, and prescribing suitable rules for its operation. Respectfully submitted,

IRVIN BUTTERWORTH,
ISAAC C. BAXTER,
G. N. CLAPP,
Committee.

SECRETARY JONES:—Gentlemen, you have heard the report of the Committee on President's Address. What is your pleasure?

It was then moved, seconded and adopted that the the report of the Committee on President's Address be received and the recommendations therein contained be concurred in.

PRESIDENT McILHENNY:—The next order of business will be a paper by H. I. Lea on the subject of

WATER-GAS TAR USED IN GENERATORS FOR ENRICHMENT.

HENRY I. LEA.

Inasmuch as but few of our theories materialize in practice, it is proposed, in this paper, to rather ignore such *ignus fatui* niceties as are represented by tables of vapor tension and of ultimate composition. In isolated cases, under laboratory conditions, close calculation is, of course, demanded and this subject itself admits of much refinement of detail. Its principal attraction, however, centers in its commercial aspect, for here it has possibilities that may be shown in black and white on the credit side of the annual balance sheet.

In the ordinary course of events, the gas company sells oil tar, not for what it is really worth, but for such prices as the tar magnates see fit to offer. Consequently, oil, tar, as such, is not, at present, very much of an asset. Unfortunately, gas companies have felt compelled to accept the tar magnate's version of the laws of supply and demand. This version exists solely because the tar men have realized that if they could but hold off on purchases for given periods, the gas companies would be compelled to accept low prices through sheer lack of storage facilities. In other words, the tar men have actually provided such storage, in tankage and in finished product, with the natural result that the gas company must pay for it. The gas company's conservatism is paying for the tar man's venture—a state of affairs less pleasing than annoying.

Of counter-irritants, however, we have three:

First.—We may provide such storage capacity as will enable us to hold our product for fair markets.

Second.—We may work up the tar itself into roofing paper, etc.

Third.—We may use the tar made as an enricher for water-gas, in practically the same way as oil is used.

The first alternative ordinarily has the objection of great initial expense.

The second involves a thousand technicalities that might be better cared for in an independent concern.

The third has all the advantages of the first two, involves practically no expense whatever and brings up no complications.

Theoretically, the varying proportions of free carbon in oil tar would render it rather difficult to handle successfully. This very objection, however, only calls attention to the conditions rendering such inequalities possible and reminds us that the entire process of water-gas making is carried on with so many variables, that an additional one, within certain limits, could be traced only with great difficulty.

Various successful attempts have been made to convert coal tar into gas. See the Peebles process, the Dinsmore process, the Mond process, the Lowe Coke Oven Process, etc. But comparatively few have been made in connection with oil tar.

Omaha and Kansas City (both U. G. I. plants, having, for the writer, no available data), have for some time used oil tar in generators, but when making down runs only. When used so sparingly, the tar has, obviously, but slight chance to prove its real value. There have been a few other attempts in this connection, but as far as the writer has been able to learn, nothing definitely favorable was arrived at under the older method of injecting tar over the top of the fuel bed, for down runs only.

The Detroit City Gas Company has, however, gone into this matter quite extensively and by spraying the pre-heated tar over the fuel bed for "up"-runs as well as "down," has obtained some very promising results. Most of their experiments were carried out at Station "B" on one of a pair of 10-foot settings, making as high as 2,800,000 cubic feet per day. The tar, however, was used in only one machine at a time. At frequent intervals, the use of tar was discontinued, but with no appreciable difference in results. In other words, such quantities of tar as were used, did satisfactorily replace equivalent quantities of gas oil. The ultimate test in this case is, of course, the number of candles per gallon, assuming that the thermal value of product remains satisfactory, which, within limits, is does.

Through the courtesy of the Detroit City Gas Company, the writer is in possession of the detail records of operation and in the following table presents a brief summary covering four representative months' operation.

WATER-GAS TAR AS ENRICHER AT DETROIT.

MONTH.	Gals. oil used in carburetter.	Gals. oil tar used in generator.	Total enricher (gals.).	Per cent. tar.	Water-gas made.	Gals. enricher per M.	Average candle-power.	Candles per gallon enricher.
June	164,530	10,980	175,510	6.3	42,066,000	4.17	23.01	5.51
July	125,528	15,072	140,600	10.7	32,554,000	4.39	22.91	5.22
August	145,236	52,240	170,476	14.8	43,493,000	3.85	21.21	5.51
September ..	136,060	17,080	153,140	11.1	40,022,000	4.24	22.64	5.34

The daily records above mentioned also show that when oil alone was used, an average of 5.4 candles per gallon was obtained throughout this same period. By the way, the figures in column showing candles per gallon represent gross results, the net being, of course, about 10 per cent. to 15 per cent. higher.

The above table shows clearly that the cause of variable results as to candles per gallon is not the use of tar, for June shows the same number of candles per gallon when only 6.3 per cent. tar was used, as does August, when tar used equalled 14.8 per cent. And in both these months, better results were obtained than are shown by an extended series of tests using oil alone. Let not this statement be taken as indicating a higher value for tar than for oil, for such interpretation would be obviously incorrect.

But the record does convincingly establish the fact that the use of tar does not necessarily lower the effieciency of operation, nor involve noticeable changes in the finished product. There are, doubtless, certain re-arrangements of hydrocarbons which might be traced by analysis at the plant, but for commercial purposes, the water-gas made while using oil tar is fully the equal of water-gas as ordinarily made, volume for volume.

And this satisfactory result is reached with very little modification of the ordinary water-gas plant, the entire scheme being to pump pre-heated oil tar through a meter and then under about 30 pounds pressure through an ordinary oil spray, onto the top of fuel bed in generator.

The tar pump is controlled automatically, as is the oil pump, and the tar spray is thrown on with the oil spray, on the drop of the stack valve. The tar spray requires more steam during periods of blast than do the oil sprays, but this, of course, is a matter of small moment.

The use of tar involves no additional charge whatever for labor and the ordinary operator can readily watch the additional spray. No special precaution is taken in the removal of water from the tar, the pre-heating being done solely to facilitate handling. There are, in fact, no serious objections of a practical nature, to the use of oil tar.

The question as to its use must, therefore, be decided wholly by relative market values of oil and tar, for, obviously, such plants as obtain as much per gallon for tar as the oil costs them, have nothing to gain through the use of tar in generator. Such cases are, however, comparatively rare. Furthermore the question hinges largely on quality of oil used, as affecting quantity of tar made.

W. E. McKay, of Boston, has perhaps, made as careful records on this point as are to be had and following are his results:

PER CENT. YIELD OF TAR IN LOWE DOUBLE SUPERHEATER.

	Maximum.	Minimum.	Average.
With naphtha	3.5	1.7	2.6
With gas oil	18.3	12.3	15.6
With crude oil	15.1	11.8	13.5

The above percentages represent tar practically free from water, and, although the results with the crude and gas oils are rather higher than ordinarily given, accompanying data would indicate highly efficient working of apparatus.

Disregarding the plants using naphtha as being too few in number to be of consequence, a notably conservative estimate of tar produced would place the figures at 10 per cent. of oil used.

Assuming also that tar production is practically a constant per centage, regardless of size of apparatus, we are prepared to carry out our calculations for any given plant along strictly conservative lines.

Before dong so, however, the writer would call attention to the importance attaching to concerted action by the Gas Companies of the United States in this connection. For this purpose we refer to Census Bulletin No. 123, which shows that during 1900, 67,093,553,000 cubic feet of gas were sold and that 194,857,296 gallons of oil were used. It is estimated by census officials that about 75 per cent. of all the gas now produced in the United States is water-gas and over 50 per cent. of the tar made is oil tar. In 1900, oil tar alone amounted to about 24,000,000 gallons.

Even with the present enormous sales, the tar magnates are not noticeably distressed by excessive production. They still conduct their business without apparent loss and give no indication whatever of lack of market for their wares. A fair deduction is that the markets for tar products are more than keeping pace with our increased production of raw material.

Up to date, however, the gas companies have not been advised of these favorable conditions through any substantial increase of market value of raw tar. Is it not reasonable to suppose that, if 50 per cent. of present output be suddenly withheld from the market, a substantial increase in market value would at once follow?

In itself, this surely is a conservative proposition, for there are very few plants in the United States that cannot actually make money under the present market conditions, by simply using oil tar as fast as made in generator. This immediately removes from the market any temporary surplus and renders unnecessary the sometimes very expensive tar storage facilities.

As an example of the operation of this scheme in practice, we assume that a plant is making daily, 100,000 cubic feet of water-gas. Under usual conditions, this plant will require five gallons oil per 1,000 cubic feet of gas made and will produce at least 10 per cent. of tar. In other words we have one-half gallon of tar capable of replacing one-half gallon of oil in the next "run." Assuming that oil delivered costs this plant 4.5 cents per gallon and that oil tar brings only 2.5 cents net, we find, that the use of oil tar (on 10 per cent. basis) would earn 5 per cent. dividends on $7,200.

In a plant making 500,000 cubic feet of water-gas per day, the use of all tar made would, under same difference in market value, earns 5 per cent. dividends on $32,800. Similarly, for each one cent by which the gross price of oil exceeds the net market value of oil tar, a plant making 1,000,000 cubic feet of water-gas per day may earn 5 per cent. on $29,200. (Note that previous figures were based on 2-cent difference).

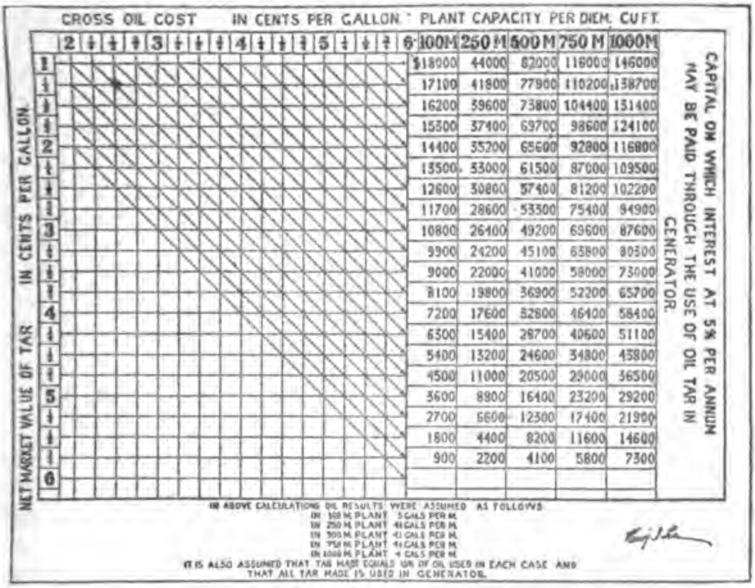
In making the calculations of which this table is a summary, due allowance has been made for increased oil efficiencies with increased size of plant, as per note below table.

In view of the fact that this matter of using all oil tar as produced, places the gas companies in immediate control of the price of over 50 per cent. of all tar produced, the writer wishes to urge the importance of most careful consideration of its advantages.

DISCUSSION.

President McIlhenny:—This is certainly a very valuable paper, and one on an entirely new line. It is a very exhaustive treatment of the subject, and I am sure it will prove to be of great benefit to the gas industry in general. Are there any comments or inquiries by any of the members?

Mr. Osbourne:—Mr. President, this seems to me to be a very comprehensive treatment of the subject and a paper that is very well prepared. Considerable thought must have been expended upon it. I would like to ask Mr. Lea if in preparing this paper he took into consideration any increased cost of running the apparatus in which he used this oil tar? From what experience I have had in this matter, it has always seemed to me—although probably my conclusions may not have been correct—that the use of tar has necessitated an extra cleaning out of the checkerwork in a very short time. I have found that it filled up the carburetter very quickly, and also the superheater in a water-gas set. It is a question probably that Mr. Lea will be able to answer from his experiments. I can only say in conclusion that the experiments made by us were made partly with the idea of saving fuel as well as the oil. That was the line on which I was working at that time. It has been some two or three years ago. We used



PLANT CAPACITY PER DIEM. CU FT.

100M	250 M	500 M	750 M	1000M
$18000	44000	82000	116000	146000
17100	41800	77900	110200	138700
16200	39600	73800	104400	131400
15300	37400	69700	98600	124100
14400	35200	65600	92800	116800
13500	33000	61500	87000	109500
12600	30800	57400	81200	102200
11700	28600	53300	75400	94900
10800	26400	49200	69600	87600
9900	24200	45100	63800	80300
9000	22000	41000	58000	73000
8100	19800	36900	52200	65700
7200	17600	32800	46400	58400
6300	15400	28700	40600	51100
5400	13200	24600	34800	43800
4500	11000	20500	29000	36500
3600	8800	16400	23200	29200
2700	6600	12300	17400	21900
1800	4400	8200	11600	14600
900	2200	4100	5800	7300

CAPITAL ON WHICH INTEREST AT 5% PER ANNUM MAY BE PAID THROUGH THE USE OF OIL TAR IN GENERATOR.

IN ABOVE CALCULATIONS OIL RESULTS WERE ASSUMED AS FOLLOWS
IN 100 M. PLANT 5 GALS PER M.
IN 250 M. PLANT 4¾ GALS PER M.
IN 500 M. PLANT 4½ GALS PER M.
IN 750 M. PLANT 4¼ GALS PER M.
IN 1000 M. PLANT 4 GALS PER M.
IT IS ALSO ASSUMED THAT TAR MADE EQUALS 10% OF OIL USED IN EACH CASE AND THAT ALL TAR MADE IS USED IN GENERATOR.

CAPITAL EQUIVALENT OF SAVING BY USING TAR.

the method of heating the tar as Mr. Lea described, or a very similar method, sprayed it from the top of the generator. We found that it took as much oil to produce the desired candle-power with the oil tar as it did without it, and no appreciable result from it, except that we had to re-checker our machine very quickly.

Mr. Lea:—Mr. President, from the results obtained at Detroit, it is apparent that if Mr. Osbourne required as much oil in obtaining a given candle-power when using tar as an additional enricher as when using oil alone, there must have been something wrong with his method of operation, in as much as the oil tar itself contains several valuable hydrocarbons. An authoritative analysis shows oil tar as containing light naphtha, toluol, benzine, anthracene cake (in itself containing about eight per cent. of anthracene) and some pitch. I can, if Mr. Osbourne wishes, give the percentages, although they would perhaps be of no material assistance at this point.

As to the deposit on the checkerwork I will say that the use of oil tar need not increase this deposit as such deposit is dependent on the temperatures carried, and the working at Detroit has not shown any increased deposit on checkerwork due to the use of tar in the generator.

Dr. Harrop:—I have no desire to criticize Mr. Lea's paper in the least. I haven't any information to add to what he has brought out, but it appears to me there are several things which he might have incorporated in his paper which would have been of some value perhaps to any one who took the paper and attempted to repeat these experiments. I understand that the results are based on data from the Detroit City Gas Works.

Mr. Lea:—Yes, sir, and the form of apparatus was a Lowe form of the Western Gas Construction. The oil used was the regular gas oil used right along, of 30 to 32 degrees Beaume specification.

Dr. Harrop:—Now as to the nature of the tar that was produced and then re-used in the setting. Have you any figures, Mr. Lea, on the quantity of water present in the tar as you find it in the generator, and the percentage of naphthaline and the percentage of free carbon or anything else that would bring out the exact conditions under which these tests were made?

Mr. Lea:—About five to nine per cent. would cover the water contained, but I am not sure of that. I have no figures with reference to naphthaline.

Dr. Harrop:—These matters are not of great importance, but what I am trying to do is simply to indicate that a paper like this has a certain value always, and if we can increase the accuracy of the statements of conditions under which we have operated in making the experiments, it will increase to a very large degree the value of the paper, and then it will become a matter of record as material for reference at any time hereafter. The sets were of what size?

Mr. Lea:—Two sets, each 10 feet 6 inches diameter.

Dr. Harrop:—Do you know anything about the temperatures carried?

Mr. Lea:—No, except that they were considered normal.

Dr. Harrop:—What effect did you find in re-using this tar?

Mr. Lea:—The tar is heavier, but how much heavier we do not know.

Dr. Harrop:—Those are only a few ideas that occurred to me during the reading of the paper, and I thought I would bring them out for the sake of having them on record.

Mr. Robb:—Mr. President, I would like to ask Mr. Lea, during his test of the tar that was used, whether there was any tar remaining, and, if so, what amount and what per cent.?

Mr. Lea:—As I say, you would use about ten per cent. of volume. You may have to use a little more than ten per cent. In a good many of these tests the percentage of tar ran beyond ten per cent., and in a few instances it ran as high as forty per cent. But it goes to show that you can use a great deal more than you are producing. Without any deleterious effect on the quality of the gas, ten, twelve or fifteen per cent. is regularly used.

Mr. Osbourne:—I just wanted to state that we have made tests along the same line, although I have no data that could be furnished at this time. A chemical test of the gas was taken after it left the washer each time. The heats were no higher as far as we could ascertain. We attempted to run under normal conditions, using about half a gallon of oil per thousand feet. as near as we could fix it, and, as I have said before, we have not had any experience whereby it was necessary to clean out our checkerwork before, but the percentage of carbon that landed on our checkerwork in the carburetter was such that it demanded attention very quickly after we made those tests, and it showed that this was the cause of it, because before and after we had no trouble. We made these tests for possibly two weeks. Some of the people in the company had taken the trouble to go to Kansas City, where they were using tar, and they came back strong advocates of it, and carried on the tests. Whether these tests were made under the best conditions or not I cannot say, but all these experiments and the chemical analysis made went to show that the results were such that we did not adopt the use of this system. You may take that for what it is worth. I do not wish to say anything which would keep anyone else from using tar, because, as Mr. Lea has very plainly stated, there is a time coming, and very shortly, when we will have to find a market for our tar. The increase of the coke oven work, and the tar coming from it, and the quality of it being so much more valuable than the water-gas tar, it raises a problem which we will have to face as to the disposion of our tar. It seems to me there will be a time when we will have to get a better market for it, or take such prices as will hardly be worthy of our consideration. That is the way the tar people talked to me, anyway, when I tried to get a contract for tar for the coming year. Of course, there have been many suggestions about using it in the boiler, etc. I would say that I found that to be a very good place to use it, but as I understand Mr. Lea's paper, he brings out a more valuable way in which to use it.

It was then moved, seconded and carried that Mr. Lea be extended a vote of thanks for his very excellent and valuable contribution.

President McIlhenny:—We will next have a paper upon the subject of Industrial Gas Fuel Appliances, written by J. Charles Andrews, of Denver, Col. Mr. Andrews was unable to be present, but Mr. Doty is here from Denver, and we will ask him to kindly read it.

Mr. Doty:—The paper is rather short and as this will be the first time that I have read it, with your permission, I will read it in extenso. Of course, I am very familiar with the work that Mr. Andrews has done, and it will stand as a monument to the man who conceived the idea and to the men who carried it out. I believe there were some pamphlets which were sent here for distribution in connection with this paper.

Mr. Doty then read the following paper:

INDUSTRIAL GAS FUEL APPLIANCES.

J. CHAS. ANDREWS.

The name gas fuel appliance carries with it thoughts of a day load—something that will increase the day output of gas and thus reduce the investment in plant and distribution system per thousand feet of gas sold.

The distribution system of any gas plant must be equal to the maximum hourly demand, and this usually occurs between six and seven in the evening. At other hours of the day more or less of the capacity of the system is idle and therefore earning no return on the investment. How to bring the minimum demand as near as possible to the maximum demand is a most vital question to gas managers. The fuel gas appliance would seem to answer this question, and more especially the industrial fuel appliance, because usually it is operated only during the daylight hours.

Having decided this, the next question is how to increase its use.

Few people, either gas consumers or prospective gas consumers (and we have been taught in Denver that this phrase covers all establishments on our lines of main) or even managers have any conception of the infinite number of fuel gas appliances on the market today, and the great variety of purposes for which they are adapted.

The proposition narrows down, or perhaps it would be more accurate to say, broadens out to this; wherever heat is required gas is the cleanest, quickest, most convenient and reliable fuel. And when cartage and storage room for solid fuel and ashes, the difference in floor space required for the appliance, the time saved to the workman when using gas, the quality of work done, the lower insurance rates—when these items are considered in the cost, gas will be found the cheapest fuel for a majority of purposes. That it would be easier to list those purposes for which gas appliances have not been made and successfully used, than to list those for which they have been, the writer knows from experience.

These facts were not generally known to our fellow townsmen —how best to inform them was the paramount question. It was then that the idea of a catalogue illustrating these appliances and pointing out their manifold uses was born.

The field was so large that it was not deemed expedient to cover it all; the work was confined therefore to industrial appliances. But even to represent all of these would have required a volume of enormous proportions. It was decided to represent types of appliances only to show, if possible, an appliance for every known use to which gas can be put for industrial purposes and to refer possible consumers to the gas company for more detailed information regarding the various makes.

The compilation was begun by addressing a circular letter to all gas companies in this country and Canada, requesting information regarding the various appliances in use. The replies to this letter were followed up by correspondence with the manufacturers. Gradually a vast assortment of information, cuts, photographs, drawings, etc., was accumulated. This accumulation was sorted and re-sorted, arranged and re-arranged, and finally when it became apparent that the work could be continued indefinitely, and that it would be better to issue a revised edition at some future time than to hold this one up too long, it was sent to press.

To comment on all these appliances would be to re-write the catalogue. It might not be amiss to say, however, that the larger mangles used in laundries for ironing heavy work, such as sheets, table cloths, etc., have never been designed for gas heat. A number of small mangles are heated by gas, but the large ones with four, six and eight rolls have always been heated by steam. It is claimed by the manufacturers that the large amount of heat required to evaporate the immense quantity of water held in suspension by this class of work as it comes from the extractor, would make the cost of operation with gas excessive.

But the axiom, "Where heat is required gas is the best fuel," was impressed upon the representative of one of the large manufacturers until he promised to take the matter up with his house. Their mangle is so constructed that it could be very readily adapted to gas. This gentleman, from the Chicago house of A. T. Hogan Co., gave the writer to understand that if they had a call for such a mangle there was little doubt that they could supply it.

If this could be made a success, think of the enormous field to be opened up. Every one in cities sleeps between sheets, and most every one eats from a table cloth. Is this not an incentive to some hustler to induce a laundry to put in such an appliance, just to set the ball rolling?

It is the intention of the management of The Denver Gas and Electric Company to issue a revised edition of this catalogue, inserting those appliances that have been overlooked or that have been perfected since the first edition was printed. For this reason it is earnestly requested that any information regarding new appliances be sent in. So many requests for copies of the catalogue have been received that it has been impossible to supply them all on account of the limited edition. The cost per copy of this first edition puts it beyond the reach of most gas companies as an advertising medium. Electrotype plates were made of each page, so that the cost of a second edition would be materially less.

If sufficient subscribers to a second edition could be secured, to take, say, 2,000 copies, the cost per copy would be reduced to less than fifty cents, instead of nearly $2.50, as it now is. Those companies subscribing for 100 or more copies could have their names printed on the cover, title page, etc., thus making the catalogue a valuable advertisement to place in the hands of the manufacturers of their cities.

Copies composed of loose leaves, printed on one side of the page only, and placed in envelopes, have been provided for the members of this Association. It has been suggested that you would derive benefit from these loose leaves by hanging them upon the walls of your show rooms, so that your consumers may see, become interested, and perhaps install some of the appliances.

The writer would like to say in closing that this paper should have been entitled "Industrial Fuel Gas Appliance Catalogue," but our honorable Secretary simply published the title and notified the writer that he was expected to write a "short topic," and he has done his best.

DISCUSSION.

PRESIDENT McILHENNY:—Gentlemen, these catalogues referred to in the paper are at the disposal of the members. This is a very excellent contribution, referring both to the paper and to the catalogues. It is the most exhaustive catalogue in the nature of gas appliances that has yet been produced. Are there any questions or comments to be made?

MR. STONE:—We have had very good success in putting them in. The chief difficulty we have to overcome is the selection of an appliance peculiarly adapted to the work. The high price of gas makes it absolutely necessary to get appliances adapted to the kind of work which it is desired to do. There does not seem to be anv advertising done by the makers of the different styles of industrial fuel gas appliances. Information in that regard seems to be lacking. Until such time as I secured a copy of this catalogue, issued by the Denver Gas Company, I was altogether at sea with regard to where to buy the various kinds of appliances we needed to fulfill particular conditions. While Mr. Doty was reading this paper I was wondering whether some scheme could be evolved by which information of this kind would be open to the members of this Association, so that when we had a place where we could put a particular kind of appliance we could write to some one and find out who made a machine of that type or who made appliances of that type and then take up the matter with them. The difficulty appears to be for the members of the Association to ascertain the makers of these machines, and to induce the manufacturers of the different appliances to get the cost of the appliance down to what the consumer considers a reasonable limit. A man does not feel like investing $75 or $100 or $150 in a forge. It looks like a pretty big price. It may be worth that amount to him, but the gas man has considerable trouble in convincing him of that fact. If there could be a list of manufacturers of these machines, I think it would be a great help.

Donald McDonald, Louisville, Ky.:—I believe all I have to say is that about one-half of the machines on the market are failures. In recommending these machines to consumers, if we were in a position where we could give them absolutely correct advice, as to which are the best, I think it would be of great help. A good many of these machines, while they can be made a success, have points about them that have to be watched and without that they will prove to be failures. I was thinking that we might have a plan by which some one of our own representatives, not representing entirely the manufacturer, would be placed in a position where he could furnish us the desired information, so that if we desired to install a particular machine, this representative of ours could caution us to have the consumer look after points requiring particular attention, so that every means possible would be taken to insure the successful operation of the machine. A salesman will recommend a machine to do anything. If, on his recommendation, you advise the consumer to buy it and he does so, the first thing you know he comes back to you and asks you why you recommended it, claiming that it is not as recommended.

In other words, if we were in a position to furnish each other the knowledge which we obtain from experience in the sale of these appliances, I think it would be very valuable indeed.

MR. BUTTERWORTH:—Mr. President, I think the catalogue contains the name and address of a manufacturer of each of these appliances and each one of these manufacturers could be written to and I should think they would be very glad to give the names of the gas companies using the particular apparatus and in that way Mr. McDonald could easily obtain a list of the gas companies using the particular apparatus about which he desires information.

MR. McDONALD:—Mr. President, I want to certainly congratulate the gentlemen who got this catalogue up. It is the most complete that I have ever seen and it is certainly a most valuable piece of literature to every gas man in the country. It is something that I have wanted hundreds of times, and I think the members of the gas fraternity are to be congratulated upon having a member so progressive and so industrious as to be able to furnish to us a catalogue as complete as the catalogue submitted in connection with this paper.

It was then moved, seconded and carried that a vote of thanks be extended to Mr. Andrews for his very valuable paper.

GAS LITERATURE INDEX.

PRESIDENT McILHENNY:—We have here some communications which I will present to you. We have a letter from F. H. Shelton, Chairman of the Library and Index Committee of the Western Gas Association, sending a sample index which was issued under the auspices of the Western Gas Association, comprising practically all gas literature. He sends a copy of the index so that it may be on exhibition and also presents it to the Association. If any members of the Association desire to obtain a copy of this index they can do so by communicating with Mr. Shelton. There is a certain plan established for the payment of these indexes rated on the output of the gas company which may desire the index. His letter to the Association in relation to this matter is as follows:

To the Ohio Gas Light Association:

GENTLEMEN:—You are probably familiar with the fact that the Western Gas Association in the past year has completed a Card Index of the most important gas reference articles for the convenience and use not alone of its members, but all those in the gas business who may desire it. A sample of this index has been forwarded to your Secretary and is in the room at this meeting for examination. This index covers some 1,300 references to all contributions to the New England, the American and the Western Gas Associations from the beginning, 25 years or more ago, and to all the articles in the *American Gas Light Journal* on current topics for the past five years and to all the books published on gas matters. With it any one can immediately find practically what has been written of importance on almost any gas subject whatever. The matter is called to your attention as it is felt that some of your members may be glad to become more familiar with what this index is and to procure copies of it.

The price established by the Western Association is on a sliding scale based on the output of the companies who may purchase a set, and will be found attached to the sample set that the Secretary has.

Any orders should be sent to me, 1004 Pennsylvania Building, Thirteenth and Chestnut streets, Philadelphia.

Yours truly, F. H. SHELTON,
Chairman Library and Index Committee, Western Gas Association.
Philadelphia, Pa., February 8, 1904.

MR. STONE:—Mr. President, as Mr. Shelton has made the Association a present of the file containing a very valuable index, I desire to make a motion that a hearty vote of thanks be extended to him for the index presented.

The above motion was then duly seconded and unanimously adopted.

ST. LOUIS EXPOSITION.

PRESIDENT McILHENNY:—We also have a letter from F. H. Shelton, calling attention to the exhibit of the gas industry at the World's Fair at St. Louis, which opens May 1 next.

This letter is as follows:

To the Ohio Gas Light Association:

GENTLEMEN:—You are no doubt familiar with the fact that the Western Gas Association is arranging for an exhibit of the gas industry at the World's Fair in St. Louis that opens May 1.

The Western Gas Association herewith extends to the officers and to every member of your Association a hearty invitation to visit this gas display and the exposition and to accept the hospitality that it is promising itself the pleasure of extending to every gas man who may this summer come within its gates.

The regular meeting of the Western Association will be held this year not in May, as usual, but in the middle of June. You are cordially invited to visit St. Louis in that week, if possible, and participate in our convention, in addition to visiting the exposition and the gas display.

The exhibit that the Western Association is arranging while including, naturally, standard things with which we are familiar, will nevertheless include a number of new features that will make it of special interest and particularly worth while to visit. We shall have, for instance, an operating model of the new centrifugal coal projecting machine for charging retorts in an entirely new, ingenious and efficient manner; samples of incandescent mantle burners of inverted or pendant form, something not heretofore on the market in this country; a showing of station meters with an entirely new style of index, superior to that we are accustomed to; samples of concrete purified construction, and apparatus illustrating the handling of gas at high pressure and numerous other novelties and innovations. The Western Gas Association has worked hard to arrange an exhibit that it believes will be creditable, not alone to it, but to the whole industry to which we are all loyal, and it believes it has succeeded.

It asks you to come and judge for yourselves; visit with us in St. Louis in the middle of June, and accept the hospitality of the Western Association there. Yours truly,

F. H. Shelton, President.

Philadelphia, Pa., February 8, 1904.

GAS CONGRESS.

President McIlhenny:—We also have a letter from C. J. R. Humphreys, Chairman of the Gas Congress Committee. As we all understand, this Gas Congress is to be a general gathering of all those interested in the gas profession. It is expected that a number of engineers from abroad will be present, and it will undoubtedly be a very noteworthy event in the gas industry. All of the associations in the country are joining in this matter. Each association has appointed a committee to take action in reference to the matter, and it is requested, or suggested, rather, in these communications that this Association appoint a committee of three to act in conjunction with the other committees. It is also suggested that there may be some expenses attendant upon the Gas Congress and it has been thought that the most feasible and desirable method of obtaining funds would be an appropriation by the different gas associations instead of making any call, if possible, upon the members of the associations themselves. The letter of Mr. Humphreys is dated at Lawrence, Mass., March 11, 1904, and is as follows:

To the Ohio Gas Light Association:

GENTLEMEN:—Enclosed please find copy of a circular note which I have sent to Mr. Jones, Secretary of the Ohio Association, as well as to the secretaries of all the other gas associations throughout the country.

I trust we may have the active co-operation of your Association in our efforts to make a success of this the first Gas Congress to be held in this country. We are particularly desirous that this should be a Congress of Gas Associations, and that every such body throughout the country will give us the beenfit of their moral support, and co-operate with us heartily, in order that the Gas Congress of 1904 may compare favorably with the various other congresses which are to be held this year in St. Louis.

I am sure we all feel a personal pride in our profession, and that every gas association in the country will be more than glad to contribute to the success of the meeting, and that the members of the gas fraternity may feel that in contributing to the success of the Congress they will be advancing the interest of the profession they represent. Yours very truly,

C. J. R. HUMPHREYS,
Chairman Gas Congress Committee.

PRESIDENT MCILHENNY:—The circular letter referred to in the letter just read is as follows:

John D. McIlhenny, Pres. Ohio Gas Light Association:

DEAR SIR:—The American Gas Light Association cordially invites the Ohio Gas Light Association to participate in a Gas Congress, to be held at St. Louis, June 15, 16 and 17, a time when it is thought the Louisiana Purchase Exposition will be at its most interesting stage.

Never before in the history of the gas industry has an effort been made to hold a congress of all the gas associations of America, and it is felt by the Committee of the American Gas Light Association having the matter in charge, that the Louisiana Purchase Exposition offers a most excellent opportunity for the gas associations thus to meet together, that the gas men from the North, the South, the East and the West may discuss subjects of mutual interest, each contributing from his information and experience to the common storehouse of knowledge, and each in his turn enriched by drawing upon that same fund of information made up by the experience of men living thousands of miles apart, but all interested in a common cause. Add to this thought the attractions offered by the exposition and surely the occasion would seem auspicious for the first Gas Congress of the gas associations of America.

There are scattered throughout this country eleven gas associations with a membership of about 2,000, and it is confidently thought that if these associations join with the American Gas Light Association in such a gathering it could not but be a pleasurable occasion, it could not but be a profitable occasion, and it could not but redound to the advantage of those pecuniarily interested in the gas industry.

The nucleus of a good attendance is assured by the fact that the Western Gas Association has arranged to hold its annual meeting on the day before the opening of the Congress, to have only a one-day session, and then adjourn to meet with the Congress.

It is intended that the appropriate officers of the participating associations should be Vice Presidents of the Congress. It is intended to invite gas engineers from abroad to participate in the Congress.

As the time for the preparation of the various details of the Congress is short, we would urge you to appoint a committee with power to act in this matter.

Yours very truly, C. J. R. HUMPHREYS,
Chairman Gas Congress Committee.

New York, February 17, 1904.

PRESIDENT McILHENNY:—What action will be taken upon these communications:

MR. DOHERTY:—Mr. President, I move that a committee of three be appointed to represent the Ohio Gas Light Association in this Congress of American Gas Associations. I think that the

Ohio Gas Light Association is heartily in favor of anything which will promote progress, and we should support this Congress, both individually and as an Association. I would therefore also move that the Association subscribe $100 towards defraying the expenses of the Congress.

MR. BUTTERWORTH :—I will second this motion.

And thereupon the motion above made and seconded was unanimously adopted.

[After adjournment of meeting, the newly elected President, F. W. Stone, complying with the above motion, named the following committee to represent the Ohio Gas Light Association at the Congress of American Gas Associations: Henry L. Doherty, John D. McIlhenny and T. C. Jones.]

PRESIDENT McILHENNY :—The Secretary has a communication to submit from the Executive Committee.

SECRETARY JONES :—Mr. President and Gentlemen, I am requested to submit the following:

ADDITIONAL REPORT OF THE EXECUTIVE COMMITTEE ON HONORARY MEMBERS.

To the Ohio Gas Light Association:

GENTLEMEN :—The Executive Committee begs leave to offer the following recommendation: That B. E. Chollar be elected to honorary membership.

Respectfully submitted for the Executive Committee.

T. C. JONES, Secretary.

Cleveland, O., March 17, 1904.

PRESIDENT McILHENNY :—What action will be taken upon the report of the Executive Committee?

MR. BUTTERWORTH :—I move that the report be adopted by a rising vote upon the recommendation of the committee that Mr. Chollar be made an honorary member of this Association. He is certainly worthy of it, as we all well know.

The above motion was then duly seconded and unianimously adopted by a rising vote.

[The Secretary notified Mr. Chollar of the action of the Association in unanimously electing him as an honorary member and later received from him the following reply:

T. C. Jones, Delaware, O.:

My Dear Mr. Jones:—After more than a week I find myself still unable to give proper expression to the feelings of surprise and gratitude with which I read your letter.

I was quite satisfied to have my name on the roll as an active member. I do not think my activity was sufficiently vigorous to merit higher honor. But the Association thinks differently, and I hope and trust that no action of mine may ever give them cause to regret their action. Yours truly B. E. Chollar.

2840 Troost Ave., Kansas City, Mo., March 29, 1904.]

President McIlhenny:—The next order of business will be the Report of the Committee on Standard Methods of Testing Fuel Gas Appliances. Mr. Doherty, I believe, is chairman of that committee.

Mr. Doherty:—Mr. Chairman, I will just read a portion of this report and abstract a portion of it, with the idea of getting suggestions, and perhaps a discussion that will be of benefit in the future work of your committee.

Mr. Doherty then read the following:

REPORT OF THE COMMITTEE ON STANDARD METHODS OF TESTING GAS FUEL APPLIANCES.

To the Ohio Gas Light Association:

Gentlemen:—Your committee wishes to recommend to the Association that its report of last year be amended by substituting a new report, which we think should be in the form of a detailed explanation and should be published in pamphlet form and supplied to all gas companies and appliance manufacturers. Considerable interest has been evidenced in the work of this committee, and, on the other hand, many appliance manufacturers and gas companies have seemed to oppose it. Others seem to think that it is the wish of this committee that economy of operation should be considered of paramount importance to all other desired features in gas appliances. This is not the position of your committee, for we recognize that economy alone does not determine the value of an appliance. The degree of satisfaction of results is of prime importance, and satisfactory results cannot in any way be compensated for by economy. We presume, however, that no gas man will disregard in the future, or has disregarded in the past, the consideration of satisfactory results secured from appliances, their artistic appearance, workmanship, ease of repairs, ease of cleaning and durability.

Many factors which go to make up the most desirable range from a commercial standpoint are matters of opinion to be determined by visual inspection. Economy is not so easily determined, and some of the foremost appliance manufacturers confess that they do not know the exact economy of the gas appliances they manufacture, the extent of the losses, or the division of these losses. High economy should not in any way interfere with other desirable features of gas appliances, and as a rule, should contribute to, rather than detract from, these desirable features. Your committee assumes that every manager believes it to be to his company's interest to supply the appliance which shows the highest efficiency consistent with other desirable features.

For the benefit of those who are not entirely familiar with this work it may be well to state that until our last convention no attempt had ever been made to establish standard methods for testing fuel gas appliances. Miscellaneous methods are in use which could only result in conclusions which failed to agree. The purpose of this work is to reduce the testing of gas fuel appliances to a condition where the same conclusions will be reached no matter where, when or under what conditions the investigation is made. It is also the purpose of this work to determine what portion of available heat in the gas is made to do useful work and what portion is lost. Further, it is the intention of this work that these losses shall be subdivided into their determining causes to enable the designer and the purchaser to curtail these losses or, if possible, to eliminate them. The simplest means possible are recommended for this work, but your committee realizes that we are probably far from the best solution of these various problems. We are simply doing what we can and asking for all the help which can be secured.

The field for gas fuel is practically unlimited, and the extent to which gas is used depends upon the aggressiveness of the management of the gas companies, the price of gas and the efficiency and durability of the appliances available. It is possible to materially increase the efficiency of all gas-burning appliances, and your committee believes that it is possible to open up more extensive fields for the use of additional gas in this way than could be secured by a reduction of 25 per cent. in the average selling prices of gas.

The apparatus for conducting these tests is inexpensive, but sometime an expense must be incurred by each gas company which wishes to be thoroughly informed regarding the desirability and availability of various gas appliances. This expense, however, is insignficant compared with the great benefits which can be secured by this knowledge. Compare, if you will, the expense of research work on this problem with a material reduction in the price you are charging for gas, and the insignificance of this expense will be made apparent.

With this explanation we will take up the detailed methods of doing this work, and it will be the aim of your committee to outline the methods it recommends in a way intended to be intelligible to the man who does not enjoy a technical education and in a way which will enable this work to be taken up by an ordinary workman without demanding more than minimum attention from the manager or engineer wishing to adopt these standard methods.

Henry L. Doherty, Chairman,
F. W. Stone,
John Franklin, *Committee.*

Mr. Doherty:—I will make a few comments on our work and will touch upon some matters which may be of considerable interest to you. Our first heading will be

Gas Supply, and we call attention to the necessity of having uniform pressure. We also comment upon the effect of *pressure* and try to counteract an error which we believe is prevalent among most gas men, to the effect that high pressure adds materially to the efficiency of a bunsen burner. This is only so when the checking is done entirely at the orifice of the burner and the full potential of the gas is delivered in the form of the kinetic energy of velocity; but where you are using a bunsen burner with a fixed orifice on different rates of consumption, what you do is to change the differential pressure on each side of the orifice until only the amount of gas will pass which you wish to use. The choking effect of the pressure is accomplished at the stop-cock, right behind the orifice, and the burner works just the same whether that congestion occurred at the works or at the stop-cock. The one essential thing in any gas supply is to have gas of a uniform quality and gas of a uniform pressure.

Water Supply. We believe it possible in all cases to use the water from the street mains, but recommend the use of an automatic overhead tank, so arranged that you will have a constant head that gives you a constant supply of water, which, as a rule, is used to absorb the heat and measure the quantity which has been yielded to do useful work.

The scope of this report is only to the extent of the usual appliances. Industrial fuel gas appliances, such as brazers, forges and tempering furnaces, are left for consideration in some future report.

Nomenclature. For sake of convenience the following classification is made:

In water heaters we ask for the adoption of the name for the circulating water heater of "Circulating Water Heater." It is generally called an Independent heater.

We want a classification of instantaneous heaters as "Instantaneous Heaters," and distinguish between the two types of instantaneous heaters by the terms of "direct" and "indirect;" the *direct* being that type where the products of combustion come in direct contact with the water being heated, and the *indirect* being that type of water heater where the water is transmitted through a tube or some other arrangement that will enable the heater to be operated under a pressure of water and hot water delivered to some other location. To name types, the Douglas heater would be a direct instantaneous heater and the Monarch heater would be an indirect instantaneous heater.

The range we have divided into "top burners," the "oven" and the "broiler." To the top burners we have given the usual names. First, the *regular burner,* then the *simmering burner* and the *giant burner.* We hope to have these names used, especially in distinguishing as to water heaters, so that when one gas man talks to another both will know what they are talking about.

The circulating water heater has probably reached the highest state of development of any particular gas appliance with the exception of the direct instantaneous. There has been remarkable progress made in the circulating water heater in the last few years, and it is very much better than it was then, or perhaps, to be more exact, it is less worse now than it was a short time ago.

Efficiency.—From this chart (indicating) of tests on circulating water heaters, I do not know how many of you can see it, you can get pretty nearly anything you are looking for in the way of efficiency. Of some fourteen heaters that are now on the market the greatest variation in efficiency is 29 per cent. as a minimum and 81.9 per cent. as a maximum. You can get anything in between there. Two heaters are in this table that are made, by the same manufacturer. Their older heater has much the better efficiency, but they are pushing the newer heater, believing that has the highest efficiency. By efficiency we mean the amount of heat made to do useful work in relation to the amount of heat supplied in the gas. If you supply 100 B. T. U. in the gas, and 60 per cent. of that is put into the water, then you have a heater of 60 per cent. efficiency.

We also call attention to the fact that if the heating value of gas cannot be determined by analysis, or measurement by a calorimeter, that it is safe to take some arbitrary figure and assume that the gas is of that value and you will get comparative results. You will not be getting actual results, but you will get comparative results, and that is what you are most anxious to have.

The efficiency of gas ranges is nearly the same for all makes. There is not a great difference there. If one were to judge of the comparative results of gas ranges the assumption would be that a gas range is a perfect machine in its present shape. It, however, is not a perfect machine. There is no portion of a gas range that works to 60 per cent. efficiency.

The only change between this report and our last report is that we have used a comparative method this time by measuring the work of the oven, and we have changed the appliances used to measure the efficiency of the broiler. Otherwise the report is the same as it was last year. But it was our desire to draw it up in detail shape and print it in pamphlet form and scatter it broadcast, and to make it so plain that anyone could follow it and do the work.

We have also changed the appliance slightly for measuring the efficiency of top burners, because we find the appliance recommended by the committee, last year had too much thermal capacity, so we have put a displacer in the pan containing the water, reducing the bulk of water to about 11 per cent. of what it was formerly.

We have also given a new method for distinguishing between necessary and unnecessary flue loss, by showing how the relation between total quantity of flue loss and service gas can be determined by an analysis of the flue gas after a previous determination of how much (CO_2) would be produced from the burning of one cubic foot of service gas.

We give instructions for the use of flue gas analysis apparatus in a more detailed form than last year.

We ask for the adoption of the report as read with the privilege of making the changes in detail, and then we ask for permission to publish with the expectation that it will be done during the summer, after having made some further tests. We want to publish it in pamphlet form and distribute it among all appliance manufacturers and all gas companies, and we move that we be authorized to do so.

MR. BUTTERWORTH:—Mr. Chairman, I second Mr. Doherty's motion.

The above motion, duly seconded, was then adopted.

DONALD MCDONALD, Louisville, Ky.:—Mr. President, it is hardly fair to criticize the report of a committee before it is read —that is, before it is read in detail. I confess that I was not able to follow it as it was read by the chairman. As it is going to be amended some time before it is published, I want to ask the chairman of the committee if in testing the top burners of stoves, for example, he has taken into consideration the different rate at which the gas is burned?

MR. DOHERTY:—We have taken that into consideration.

MR. MCDONALD:—I find I can evaporate a given quantity of water with two feet of gas, or I could evaporate the same quantity of water with four feet of gas, using exactly the same burner and exactly the same gas. The only differnce being how high I turned on the gas.

MR. STONE:—There was one statement made by Mr. Doherty that no gas range had over 60 per cent. of efficiency. As I understand, that was not in the report. That was merely a personal opinion of Mr. Doherty in regard to that one matter.

MR. DOHERTY:—That was merely a comment, Mr. President, and was not a part of the report.

PRESIDENT MCILHENNY:—Any further comments or questions?

MR. DOHERTY:—Mr. President, I would like to hear some discussion on this subject, because I think it is important. Your committee admits that they are floundering in the dark, to a certain extent. It might be of advantage to find out who are using the methods recommended by the committee last year, and what results they have secured.

PRESIDENT McILHENNY:—Have any of the members present used the methods of testing the appliances recommended by the committee last year?

MR. McDONALD:—Mr. President, I will risk confessing myself to be an ignoramus by saying that the method recommended by the committee last year was so infernally complicated that I could not carry it out. The real question of the efficiency of a gas range is, how quickly it will cook biscuits, and how much gas it will take per burner? The same identical range in the hands of different cooks will show a difference in efficiency of 300 per cent. The question is, how skilfully they use it, and how clean they keep their burners and how high they turn them, and how quickly they turn them out after they have finished. Now, I do not mean to say that we cannot get something like an idea of whether a range or water heater is constructed on scientific principles. I believe a water heater that is constructed on scientific principles would show a much greater efficiency than one that was not so constructed. A good one is worth two or three times as much as a bad one. But as to ranges, the question of how easy of repair and how easily they are cleaned would, in my opinion, go away beyond any question of theoretical efficiency as to per cent. of gas used.

MR. E. G. VAN WIE, Detroit, Mich.:—I would like to ask Mr. Doherty if, in testing these various appliances, the gas consumption per hour is adjusted? For example, in testing a water heater you have the same rate per hour for each heater?

MR. DOHERTY:—Yes; both would be burned at the same rate and under exactly the same conditions to determine their relative efficiency.

MR. VAN WIE:—You reduce the inlet so that they do burn the same?

MR. DOHERTY:—We would change the stop cock. The curve I held up before the meeting showed the efficiency at each point of consumption. Starting with 10 feet and progressing five feet at a time to the maximum consumption of the heater.

PRESIDENT McILHENNY:—Any further comments on the report of the Committee on Testing Fuel Gas Appliances?

MR. KNIGHT:—I would like to ask if the committee do not consider as important also sanitary condition?

MR. DOHERTY:—Certainly. Mr. Chairman, if this work were undertaken—and it is in the providence of the Association to say whether it shall be taken or not, it is presumed that the methods as laid down by your Committe on Standard Methods for Testing Fuel Gas Appliances, would be adopted and rigidly adhered to. The changes that are made in this year's report would give the same results. The changes we have made are intended to furnish further instructions to make our former instructions more explicit and to try and simplify the tests. Mr. McDonald takes a position which is unconsciously one calculated to retard progress. He points out the inability of the committee to procure methods of testing and to give instructions that are simple, or, at least they seem to him, complicated. Now, perhaps they are complicated, and perhaps they could be greatly simplified, but we have to have some standard method of testing these appliances if we are going to pay any attention at all to efficiency, and we must take the best we can evolve at this time. If we could get the hearty support of the Association in trying to simplify them, we would probably be able to produce a report which would be more generally satisfactory. We will be only too glad to listen to any suggestions that any of the members of the Association can give to us.

Now, Mr. McDonald also voices the sentiment of fifty or sixty per cent. of the gas fraternity, and about ninety per cent. of the manufacturing fraternity when he says that efficiency is a matter of relatively small importance compared with other things. I think that position is taken because the efficiency of the present gas appliance is greatly overestimated, and I think also the position of the committee is not thoroughly understood. We are not advocating a disregard for other features. We are, in fact, hoping that more attention will be paid to the other features from now on than has been paid in the past. But if we are to take the positon that efficiency is of relatively small importance and not determine what the efficiency is, it means that we will neglect this important factor entirely, and will not care whether we get 29 per cent. efficiency out of a water heater, or whether we get 82 per cent. Now, if there is nothing about a highly efficient appliance as a rule which will jeopardize or lessen any of the desirable features of a gas appliance, as it is now constructed, then why not ascertain those appliances which are the most efficient, and other things being equal, why not recommend their use? A high degree of efficiency will also permit desirable features in many appliances to be increased. It is easily possible for each manager to determine these points. Mr. McDonald brings up the question of durability, ease of repair and matters of that sort. It is not an easy matter to determine efficiency. The curve which I showed you on water heaters shows results varying all the way from 29 to 82 per cent. Now, every manufacturer, submitting a heater, maintains that his heater is the best, and most of them, I think, believe it is the best. One manufacturer, for instance, is going wild over a certain heater which he believes will revolutionize the world; its efficiency is about 55 or 58 per cent. He has a pet theory, and, according to him, all the books on physics are wrong about the burning of gas, and he has discovered the only proper solution of it.

I would say in conclusion, Mr. President, that I would like to see the matter placed in the hands of men whose work would be of such character and who would be so situated, that the results they obtained could not be questioned.

We therefore feel that if the Association takes up this work, it should be carried on in the laboratories of the Ohio State University, or if the work cannot be carried on there, it should be carried on at some of the other large universities. Perdue University, at Lafayette, Ind., is a very progressive institution, and would be glad to undertake this work, I think, if the Ohio State University does not care to do it. If the Ohio State University and the Perdue University do not care to do it, I think I can assure the Association that the Wisconsin University would take it up.

DONALD MCDONALD, Louisville, Ky.:—I do not wish to be a brake upon the wheels of progress at all. I would suggest if this committee is appointed to determine efficiency, and if college students can do it, that the committee also be instructed to report on each appliance examined as to its durability. For instance, on durablity let them report that it stands six out of a possible 10 points; as to ease of repair, that it stands eight out of a possible ten; as to convenience in cooking, which is one of the most important factors, that it stands five, six, seven, eight or nine out of a possible ten points. In other words, I do not care what the most efficient stove is. I want the one that will give the best satisfaction to my customers, and efficiency is only one of the elements that enter into it. It is an important point, but I have found stoves which I have examined, and become very enthusiastic about, and after putting them into use and using them for a short time, some little screw would give out, or some of the minor parts prove defective and the whole thing would be a failure. There are practical points of this kind that enter into it which, from the standpoint of satisfaction to the consumer, are worth a great deal more than any theoretical question to be determined by a calorimeter or a university student. So that if we appoint a committee at all, let them cover the practical features of this question as well as the theoretical features, and when they report that a particular stove has an efficiency of 70 or 80 per cent. let them also report on these other points, which only experience can determine. In other words, while we are getting a guide, let us get a true guide.

MR. STONE:—There is only one objection I see to the scheme detailed by Mr. McDonald, and that is this, the question of efficiency in an appliance is a question of fact that can be definitely determined. The question of its durability or its convenience or its practicability, is a mere question of opinion, about which possibly no two persons could agree.

MR. BUTTERWORTH:—Mr. President, I will say further that it is not merely a matter of opinion, but it is a matter of experience and long continued trial to determine, for instance, the question of durability, which this proposed committee of experts would have no means of ascertaining or investigating.

MR. DOHERTY:—I agree heartily with the last two speakers, and I only want to correct an impression that Mr. McDonald's remarks may have left, that these tests would be carried on by university students without any help from some one better able to do the work. If the work were carried on at the Ohio State University, I would like to see it undertaken under the direction of Professor McGruder or Professor McCracken, or some other expert of recognized ability who would really conduct the work themselves, and simply use the students as their assistants. I want to reiterate what Mr. Stone has said, that the question of durability, and a great many matters of that sort, are absolutely matters of opinion, and were they not matters of opinion, every gas man in the country would be buying the same make of range. But they are matters of opinion purely, and therefore, it would not be a safe plan to undertake more work than such a committee can properly do. Mr. McDonald's position now is, that if one point is to be determined for him, he wants all points determined. It seems to me we would be in a better position to determine one point at a time and determine that well before attempting to have the same men who may only have facilities and opportunities for observation to determine one point, attempt to determine all of the points referred to. Now, I know positively that some of these matters are matters of opinion pure and simple. Mr. McDonald and I, for instance, could get together and we would quarrel over certain features, and quarrel all night, and in the morning we would be of the same opinion still.

MR. McDONALD:—That is so, Mr. Doherty.

MR. DOHERTY:—There is no way that certain of these points can be decided. If Mr. McDonald says that a certain stove will last ten years, and I maintain that it will only last seven years, we cannot determine the actual life of the stove during our discussion. But we can determine the efficiency of a stove and there is no chance at all for difference of opinion, after it has once been properly tested.

MR. McDONALD:—It does seem to me that if a certain make of stove has been used in my town, that the oven burns out so that I could not repair it and I have to throw that stove away, then before another trusting and confiding individual is induced to install that same stove, a committee of experts ought to be able to determine that fact, notwithstanding the stove may show an efficiency of 75 per cent. I am not saying that the determination of efficiency is not always an important matter, but if that is all the committee wants to undertake, let them go ahead and undertake it and after they have determined the efficiency, then we can appoint another committee to determine the practical points.

MR. BUTTERWORTH:—Mr. McDonald has anticipated a motion that I was going to make to appoint another committee to take up the practical points which he has suggested, other than that of efficiency. If there is nothing before the house I will make a motion that the chairman appoint a committee of three from the members of this Association to ascertain the relative practical merits of the different forms of domestic gas appliances.

MR. McDONALD:—Mr. Chairman, I would suggest that Mr. Butterworth defer that motion until after we get the report of the Committee on Standard Methods for Testing Fuel Gas Appliances.

PRESIDENT McILHENNY:—Mr. Butterworth's motion is not seconded and therefore is not before the house.

A motion was then duly made, seconded and carried unanimously by a rising vote that the hearty thanks of the Association be extended to the committee for the work performed and report submitted.

MR. DOHERTY:—I desire to submit a motion and to have the Association authorize the Secretary to make arrangements to have the various domestic fuel gas appliances tested according to the recommendations of your Committee on Standard Methods at the Ohio State University, or some other university, and report the efficiency secured to the members of this Association, and that the Association authorize the Secretary to expend the necessary amount of money, limiting the amount to be expended to the sum of $100.

The above motion then being duly seconded by Mr. McDonald, was unanimously adopted.

MR. DOHERTY:—I would like to make a motion for an absent member. The Revision Committee, which was provided for yesterday, are anxious to secure all of the gas literature they can, and it has been called to the attention of a member of the Association interested in that committee that Mr. Forstall, as Secretary of the American Gas Light Association, has an extensive card index, and I therefore move that the Association respectfully request Mr. Forstall to allow our Secretary or the Chairman of the Revision Committee to make a copy of his index, at our expense, for the use of this Revision Committee, and that the Secretary be authorized to communicate with Mr. Forstall advising him of the request of the Ohio Association, to make a copy of his card index.

The above motion was then duly seconded and carried.

PRESIDENT MCILHHENNY:—The next order of business is the report of the Committee on Final Resolutions.

Mr. Eugene Printz, Zanesville, Ohio, Chairman of the Committee, then read the following:

REPORT OF COMMITTEE ON FINAL RESOLUTIONS.

To the Ohio Gas Light Association:

GENTLEMEN:—The Committee on Final Resolutions beg leave to offer the following:

WHEREAS, The members of the Association feel that the meeting has been a most pleasant and profitable one, owing to the exertions of its President, Secretary and Committee of Arrangements, it is but fitting that the appreciation of the members present be shown by

Resolving, That the thanks of the Association be tendered them for their successful efforts. Be it further

Resolved, That the thanks of the Association be tendered the American Stove Company, the Cleveland Gas Light and Coke Company, the People's Gas Light Company, the Welsbach Company, the Gas Machinery Company and the United States Cast Iron Pipe and Foundry Company and the Hollenden Hotel, for their entertainment of our members and the fraternity generally.

Resolved, That the Secretary forward to the aforesaid copies of these resolutions.

EUGENE PRINTZ,
G. H. TAYLOR,
A. J. STACEY,
Committee.

It was then moved, seconded and adopted that the above report be accepted and spread upon the minutes of the Association.

PRESIDENT McILHENNY:—The next order of business will be the report of the Committee on Nominations, of which M. E. Malone is Chairman.

REPORT OF COMMITTEE ON NOMINATIONS.

To the Ohio Gas Light Association:

GENTLEMEN:—On behalf of the Committee on Nominations I submit the following report:

Your Committee on Nominations for this Association recommends the following:

President—F. W. Stone, Ashtabula, O.

Vice President—Donald McDonald, Louisville, Ky.

Secretary and Treasurer—T. C. Jones, Delaware, O.

Members of Executive Committee—Charles R. Faben,Jr., Toledo, O.; Paul Doty, Denver, Colo.; W. H. Barthold, Grand Rapids, Mich.

Editor Question Box—Henry L. Doherty, New York, N. Y.

Editor Progress Department—Irvin Butterworth, Detroit, Mich.

Editor Novelty Advertising and New Business Methods Department—B. W. Perkins, South Bend, Ind.

Editor Wrinkle Department—E. E. Eysenbach, St. Paul, Minn.

Editor Information Bureau—H. L. Olds, Lincoln, Ill.

Committee on Standard Sizes of Coke—C. W. Andrews, Duluth, Minn.

Committee on Uniform System of Mapping Street Mains—W. H. Barthold, Grand Rapids, Mich.

Committee on Standard Methods of Testing Fuel Gas Appliances—Henry L. Doherty, New York, N. Y.; F. W. Stone, Ashtabula, O.; John Franklin, Cincinnati, O.

Committee on High Pressure Distribution—H. A. Carpenter, Pittsburg, Pa.; J. D. Shattuck, Darby, Pa.; J. O. Johnston, Columbus, O.

Committee on Revision—Dr. H. B. Harrop, Chairman, Milwaukee, Wis.

Respectfully submitted,
M. E. MALONE,
FRANK CAVANAGH,
Committee.

Upon motion duly seconded the report of the committee was unanimously adopted.

PRESIDENT McILHENNY:—I will appoint Mr. Knight a committee of one to escort F. W. Stone, our newly-elected President, to the chair. We will then expect a speech.

Mr. Knight then escorted F. W. Stone to the chair.

MR. STONE:—Gentlemen of the Ohio Gas Light Association: it gives me a great deal of pleasure to be elected your President; more pleasure than possibly any one of you can appreciate, because I can remember, not more than 18 or 19 years ago, I was getting blisters on my feet from running back to the shop for nipples to fix services with, and blisters on my hands trying to work a pair of pipe tongs. I never expected at that time to aspire to any such position as this. I realize that with such an office comes also a sense of responsibility. I have a feeling that you have elected a very small man to a very responsible position—a man that is not capable of filling it in the excellent way in which it has been filled in the past. I could not fill it did I not feel that there is a spirit of fraternity in the Ohio Gas Light Association which makes each and every member willing to put his shoulder to the wheel and help in the work we have to do. All of you, I am sure, will be willing to give me your hearty support. The success of the Association for the ensuing year will not depend upon the effort of your President so much as upon the effort that each member will put forth in securing a successful meeting next year. I can say with a great deal of pleasure that I have never had the assistance, the advice, the help of the counsel of any member of this Association who has not been willing to open up his heart to me, and tell me all I wanted to know. I feel that there is more brotherly interest and co-operation in the gas fraternity than in any other line of business. I want you all to feel that way now, and I ask during the coming year your earnest support in any work that the Association may undertake. I assure you that I will do the best I possibly can as your President, but I have a feeling that the part I will be able to play in the matter will be comparatively small, and that the success of the work of the Association will rest in the hands of its members. I thank you.

PRESIDENT McILHENNY:—We will ask Mr. Doherty to escort Donald McDonald, our newly-elected Vice President, to the front.

MR. McDONALD:—Gentlemen, without experiencing that sort of diffidence which I either have or ought to have, I will say that I do not live in Ohio, and that I am forbidden by law from selling gas for light, so I accept this offer with the mental proviso that this is not so much "The Ohio Gas Light Association" as it is *The Gas Association.*

MR. DOHERTY:—Mr. President, I move that a vote of thanks be tendered to President McIlhenny for his very painstaking work as the presiding officer of this meeting, and for his uniform courtesy to the members of this Association; also a vote of thanks to Secretary Jones for his earnest efforts in bringing about, and carrying through to completion, a very successful meeting.

The above motion being duly seconded, was unanimously adopted.

It was then announced by the chair that a cordial invitation had been extended to each member of the Association by the Cleveland Gas Light and Coke Company to visit its plant during the afternoon.

MR. STONE:—Gentlemen, we all know that the work of the Secretary is becoming greater and more arduous each year. In addition to the regular work devolving upon him as Secretary, he has had to shoulder the work of preparing and publishing the proceedings of the Association for the last three years in book form. His present salary is entirely too meager for the work required. I realize that we will not be able to raise it to a sum commensurate with the services rendered, but I feel that, as a slight testimonial of the appreciation for his efficient services, his salary should be increased to $500 per year, and if some member will make a motion to that effect the chair will certainly be very glad to entertain it.

MR. SCHWARM:—Mr. President, it gives me great pleasure to move that the Secretary receive $500 a year hereafter.

Several Voices:—I second the motion.

SECRETARY JONES:—Mr. President and Gentlemen: I deeply feel this expression of your appreciation of my services. I am sure, however, that what I have done for the Association has been more a matter of love for the work and for the Association than by reason of the dollars and cents which it brought me. We have a good many financial obligations to meet, and the Association is taking on some new lines of work which will involve the expenditure of money, so that while I would like to have the increased pay, I hardly believe the Association is in a position to stand it just now. I therefore would prefer that the salary remain the same as heretofore.

MR. McILHENNY:—We all know it is not a question of money with Mr. Jones, for we realize that the increase suggested is in no way commensurate with the work performed by him.

MR. DOHERTY:—The Association during the past year has been fortunate enough to secure the moral and financial support of a very large number of prominent gas men throughout the country. There is no doubt whatever but that we can take care of this small additional expense and also meet all of our other obligations, which we see ahead of us, provided we can get the earnest support of the progressive gas men of the country and induce them all to become members of our Association. I realize that we have no other means of support. The only means we have are from the payment of dues. I realize that there are obligations ahead of us which are not reflected in the Association reports; but if the members will keep continually in mind the interests of the Association, and actively co-operate with the officers of the Association in retaining our present membership, and in securing new members from among the progressive gas men of the country, there is no reason why we cannot meet all of our obligations very easily. I have been connected with a great many associations, but I have never seen better or more efficient work than Mr. Jones has rendered as our Secretary. No matter what we pay him, he will be underpaid. He would be getting a certain amount in cash and rendering the balance of his services for love, and even if we pay him the increased amount contemplated by the motion, the portion of his services which he would have to render for love would be greater than the percentage of his services for which he would be adequately paid. I therefore am most earnestly in favor of the motion, and I feel that Mr. Jones should be urged to accept it.

Mr. McIlhenny:—I would like to say that during the last year I have had an excellent opportunity to observe what Mr. Jones has been required to do as Secretary. His labors have been constant and unremitting. They have been inspired by zeal and love for the Ohio Gas Light Association. I think it is entirely proper to make this addition to the salary.

The above motion was then unanimously adopted.

Secretary Jones:—Mr. President and Gentlemen: I assure you that I appreciate this expression of good will on your part very much. I can only say that I will continue to do "my level best."

On motion, duly seconded and carried, the Twentieth Annual Meeting of the Ohio Gas Light Association then adjourned.

OFFICERS

OF THE

OHIO GAS LIGHT ASSOCIATION,

1904-1905.

President.

F. W. STONE..............................Ashtabula, Ohio

Vice-President.

DONALD McDONALD....................Louisville, Kentucky

Secretary and Treasurer.

T. C. JONES................................Delaware, Ohio

Executive Committee.

JOHN D. McILHENNY......................Philadelphia, Pa.
J. D. SHATTUCK..................................Chester, Pa.
CHAS. R. FABEN. JR...........................Toledo, Ohio
PAUL DOTY.....................................St. Paul, Minn.
W. H. BARTHOLD.....................Grand Rapids, Mich.

Finance Committee.

CHAS, R. FABEN, JR...........................Toledo, Ohio
PAUL DOTY.....................................St. Paul, Minn.
W. H. BARTHOLD......................Grand Rapids, Mich.

Question Box.

HENRY L. DOHERTY, Editor................New York, N. Y.

Progress Department.

IRVIN BUTTERWORTH, Editor............Grand Rapids, Mich.

Novelty Advertising and New Business Methods Department.

B. W. PERKINS, Editor....................South Bend, Ind.

Wrinkle Department.

E. E. Eysenbach, Editor	Binghamton, N. Y.

Information Bureau.

H. L. Olds, Editor	Lincoln, Ill.

Committee on Uniformity of Gas Meters.

Alten S. Miller	Baltimore, Md.
R. Shacklette	Adrian, Mich.
Donald McDonald	Albany, N. Y.

Committee on Standard Sizes for Coke.

C. W. Andrews	Duluth, Minn.

Committee on Uniform System of Mapping Street Mains.

W. H. Barthold	Grand Rapids, Mich.

Committee on Standard Methods of Testing Fuel Gas Appliances.

Henry L. Doherty	New York, N. Y.
F. W. Stone	Ashtabula, Ohio
John Franklin	Cincinnati, Ohio

Committee on High Pressure Distribution.

H. A. Carpenter	Pittsburgh, Pa.
J. D. Shattuck	Chester, Pa.
J. O. Johnston	Columbus, Ohio

Committee on Revision.

Dr. H. B. Harrop, Chairman	Milwaukee, Wis.

Bureau of Forms and Records.

D. W. Low, Editor	Alliance, Ohio

Past Presidents.

†Andrew Hickenlooper	1884–1886
Emerson McMillin	1887
Eugene Printz	1888
Thomas Wood	1889
Edw. Lindsley	1890
Chas. R. Faben. Jr	1891
†H. Wilkiemeyer	1892
Chas. H. Welch	1893
Irvin Butterworth	1894
J. W. R. Cline	1895
Jos. Gwynn	1896
Jerome Penn	1897
W. C. Boyle	1898
†B. P. Holmes, elected for	1899
†E. H. Jenkins	1899
A. P. Lathrop	1900
George Whysall	1901
Henry L. Doherty	1902
C. W. Andrews	1903
John D. McIlhenny	1904

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† Deceased.

Past Secretaries.

Joseph M. Bate	1884–85
Irvin Butterworth	1886–93
A. P. Lathrop	1894–98

LIST OF MEMBERS.

(The date with each name is that of election to membership.)

Key to Membership in Other Associations.

A	American Gas Light Association.
B	Western Gas Association.
C	New England Association of Gas Engineers.
D	Pacific Coast Gas Association.
E	Michigan Gas Association.
F	Wisconsin Gas Association.
G	American Association for the Advancement of Science.
H	American Society of Mechanical Engineers.
I	American Institute of Electrical Engineers.
J	Society of Chemical Industry.

LIST OF MEMBERS.

(The date with each name is that of election to membership.)

HONORARY MEMBERS.

John P. Harbison, (A–B–C)............................March 16, 1887
Hartford, Conn.

George G. Ramsdall, (A–B)............................March 16, 1887
Agent, The New Inverted Incandescent Gas Lamp Co., Ltd., 530 Broadway, New York, N. Y.

George W. Græff....................................March 16, 1886
Philadelphia, Pa.

Malcolm S. Greenough, (A–B–C)....................March 20, 1889
President and General Manager, Cleveland Gas Light and Coke Co., 356 Superior St., Cleveland, O.

Emerson McMillin, (A–B–C–G–H)....................Sept. 17, 1884
President, American Light and Traction Company, 40 Wall St., New York, N. Y.

Forrest E. Barker, (A–B)...........................March 18, 1891
Chairman of Massachusetts Board of Gas and Electric Light Commissioners, Room 145, State House, Boston, Mass.

E C. Brown, (A–B–D–E)..............................March 19, 1890
Treasurer, Boone (Iowa) Gas Co.; Editor, *Progressive Age*, 280 Broadway, New York, N. Y.

Alex. C. Humphreys, (A–B–C–D–G–H–J).............March 16, 1892
President, Buffalo Gas Company; President, Stevens Institute of Technology; member of firm of Humphreys & Glasgow, 31 Nassau St., New York, N. Y.

Byron E. Chollar, (A–B)...........................March 15, 1899
Gas Engineer, 2840 Troost Ave., Kansas City, Mo.

ACTIVE MEMBERS.

Abbott, E. D. .... March 15, 1893
Superintendent, Springfield Gas Co., Springfield, Ohio.

Abell, H. C., (H–I) .... March 16, 1904
Engineering Assistant to Henry L. Doherty, Denver Gas & Electric Co., Denver, Col.

Addicks, **Walter** R., (A–B–C) .... March 21, 1894
Vice-President, Consolidated Gas Co., 4 Irving Place, New York, N. Y.

Alcott, F. L., (A–B–E) .... March 21, 1900
General Manager and Secretary, The Standard Lighting Co., Cleveland, Ohio.

Allen, G. A. .... March 19, 1890
Zanesville, Ohio.

Andrews, C. W., (B) .... March 16, 1898
President, Hamilton Otto Coke Co.; Hamilton Gas Light and Coke Co., Hamilton, O.; General Manager, Zenith Furnace Co., Duluth, Minn.

Andrews, J. **Chas.**, (A) .... March 16, 1904
Denver Gas and Electric Co., Denver, Col.

Armstrong, F. S. .... March 16, 1904
Macomb Electric Light and Gas Co., Macomb, Ill.

Arthur, **Chester** L., ... March 20, 1901
General Sales Agent, The Phillips Coal and Coke Co., Citizens Bldg., Cleveland, Ohio.

Arthur, W. A. .... March 16, 1904
Spencer Gas Co., Spencer, Mass.

Atwood, C. C. .... March 16, 1904
Engineering Assistant, New Amsterdam Gas Company, Ravenswood, Long Island City, New York.

Auner, **Harry** .... March 16, 1904
Superintendent, London Gas Light Co., London, Ohio.

Ayers, A. D. .... March 16, 1904
President, Keokuk Gas Light and Coke Co., Keokuk, Iowa.

Backus, Q. S. .... March 20, 1895
President, The Q. S. Backus Co., Brandon, Vt.

Bacque, **Louis** H. .... March 16, 1904
Manager, Three Rivers Gas, Heat and Power Co., Three Rivers, Quebec, Canada.

Bæhr, **William Alfred**, (A–B–H–I) .... March 18, 1903
Engineer, Laclede Gas Light Co., St. Louis, Mo.

Baldwin, **Wareham** S., (A) .... March 16, 1904
Kentucky Heating Co., Louisville, Ky.

Barbour, **William Tefft**, (A–B) .... March 21, 1900
President, Detroit Stove Works, Detroit, Mich.

Barnard, F. F. .... March 18, 1903
Superintendent, Wilmington Gas Light and Coke Co., Wilmington, Ohio.

Barnes, George W., (B)............................March 16, 1898
Salesman, Equitable Meter Co., 434-449 Water St., Pittsburgh, Pa.

Barthold, W. H., (A–B–E)..........................March 18, 1903
Engineer, Grand Rapids Gas Light Co., Grand Rapids, Mich.

Bash, Henry C.....................................March 16, 1904
Secretary and Treasurer, Fayetteville Gas and Electric Company, Fayetteville, N. C.

Baxter, Isaac C., (A–B–E).........................March 16, 1898
President, Bucyrus (Ohio) Gas and Electric Co., Wayne County Bank Building, Detroit, Mich.

Beadle, A. B., (A)................................March 16, 1904
82 Beaver St., New York City.

Beal, A. B..March 16, 1904
Superintendent, Newburg Light, Heat and Power Co., Newburg, N. Y.

Beam, Frank L.....................................March 21, 1900
Director, Coshocton Gas Co., and Hillsboro Light and Fuel Co., Mt. Vernon, Ohio.

Beckwith, J. W....................................March 20, 1901
Superintendent, Oberlin Gas and Eletcric Co., Oberlin, Ohio.

Bell, Robert......................................March 16, 1904
Superintendent, Fulton Fuel and Light Co., Fulton, New York.

Bender, W. E......................................March 20, 1901
Secretary, Hamilton Otto Coke Co., and Hamilton Gas Light and Coke Co., 33 N. Tenth St., Hamilton, Ohio.

Bernstein, S., (A)................................March 16, 1892
President and Treasurer, The S. Bernstein Co., 126 Sixth Ave., New York, N. Y.

Bigelow, Lucius Seymour...........................March 16, 1904
President, The Light Publishing Co., 265 Broadway, New York, N. Y.

Bill, Benjamin P., (C.............................March 16, 1904
Superintendent, Capital City Gas Co., Montpelier, Vt.

Binkley, F. C.....................................March 16, 1904
Superintendent, Gas Appliance Dept., The Turner Brass Works, Chicago, Ill.

Blanchard, Harry..................................March 16, 1904
Superintendent and Secretary, Mendota Gas Company, Mendota, Ill.

Blinn, A. C.......................................March 19, 1902
Macon, Georgia.

Blinks, Walter M., (A–B–E)........................March 16, 1904
General Gas Light Co., Kalamazoo, Mich.

Block, Barnhard...................................March 16, 1904
Special Representative, Electric, Oil and Gas Stove Works, 295 Pearl St., New York, N. Y.

Blowers, Frank W., (A–B–E)........................March 18, 1903
Secretary and General Manager, Kalamazoo Gas Co., Kalamazoo, Mich.

Boal, Stanhope, (A–B)........March 15, 1899
Vice-President, The Favorite Stove and Range Co., Piqua, Ohio.

Boone, Chas........March 16, 1904
Engineering Assistant, New Amsterdam Gas Company, Ravenswood, Long Island City, N. Y.

Booth, Miller,........March 21, 1888
Secretary, Bellaire Gas and Electric Co., Bellaire, Ohio.

Boyle, W. C........March 16, 1892
President, The Salem Gas Light Co., Perry-Payne Bldg., Cleveland, Ohio.

Brady, John T........March 16, 1904
Chief Clerk, Denver Gas and Electric Co., Denver, Col.

Bredel, Fred, (A–B)........March 19, 1900
President, Fred Bredel Co., 405 Keene St., Milwaukee, Wis.

Brooks, Harry S........March 20, 1901
Traveling Salesman, The Wm. Resor Co., Cincinnati, Ohio.

Brooks, F. F........March 16, 1904
Manager, Charleston Gas and Electric Co., Charleston, Illinois.

Brown, W. E........March 16, 1904
Manager, New Westminster Gas Co., New Westminster, B. C.

Buck, Earl H., (B)........March 18, 1903
Manager, Citizens' Gas Light Co., Vincennes, Ind.

Butterworth, Irvin, (A–B–E–I)........Feb. 18, 1885
Vice-President and General Manager, Grand Rapids Gas Light Co., Grand Rapids, Mich.

Byers, C. A., (A–B)........March 20, 1895
With Ames Bonner Co., Toledo, Ohio; Consulting Engineer, Bristol Gas Light Co.

Calendar, E. P., (A–B–D–E)........March 19, 1890
Editor, *American Gas Light Journal*, 42 Pine St., New York, N. Y.

Callanan, J. M., (A)........March 16, 1904
Superintendent, Nassau Co. L. I. Gas Co., Hempstead, L. I.

Canterbury, John P........March 18, 1896
Inspector, Denver Gas and Electric Co., Denver, Col.

Cardall, J. H., (B)........March 16, 1904
Superintendent, Huntsville Gas Co., Huntsville, Ala.

Carpenter, H. A., (A–B)........March 15, 1899
Engineer, Riter-Conley Mfg. Co., Pittsburgh, Pa.

Cartwright, H. R., (A)........March 16, 1904
Manager, American Meter Co., Arch and Twenty-second Sts., Philadelphia, Pa.

Cavanagh, Frank........March 18, 1903
General Manager, Consumers Gas Stove and Fixture Co., 260 Prospect St., Cleveland, Ohio.

Chambers, R. J.,........March 16, 1904
Superintendent, Montgomery Light and Water Power Co., Montgomery, Ala.

Chase, Louis........March 16, 1904
Salesman, Liberty Mantle Mfg. Co., 81 West Kinsic St., Chicago, Ill.

Clansen, W. F .... March 19, 1902
Superintendent, Portsmouth Gas Co., Portsmouth, Ohio.

Clapp, G. N., (B) .... March 20, 1899
Secretary, Treasurer and General Manager, Middletown Gas and Electric Co., Middletown, Ohio.

Clark, George M., (B) .... March 19, 1890
President, George M. Clark & Co., 72 Lake St., Chicago, Ill.

Clark, Horace F .... March 16, 1904
Salesman, H. Mueller Mfg. Co., Decatur, Ill.

Clark, Walton, (A–B–C–D–H) .... March 15, 1899
General Superintendent, United Gas Improvement Co., Broad and Arch Sts., Philadelphia, Pa.

Cobb, B. C., (A–B–E) .... March 18, 1903
Secretary and General Manager, Saginaw City Gas Co., Saginaw, Mich.

Cochran, Horace J .... March 16, 1904
Manager, Maysville Gas Co., Maysville, Ky.

Collins, David J., (A–B–D–E) .... March 20, 1895
Sales Agent, United Gas Improvement Co., Broad and Arch Sts., Philadelphia, Pa.

Collins, Warren, (A) .... March 16, 1904
General Manager, Sales Dept., Stamford Gas Stove Co., Stamford, Conn.

Congdon, R. C.. (A) .... March 16, 1904
Manager, Frederick Gas Co., Frederick, Md.

Connelly, J. S .... September 17, 1884
President, Titusville Gas Co., Titusville, Pa.

Coombs, Moses .... February 18, 1885
Superintendent, Gas Department, Youngstown Gas and Electric Co., Youngstown, Ohio.

Coombs, Fred S., ... March 21, 1900
Superintendent, Meter Department, Youngstown Gas and Electric Co., Youngstown, Ohio.

Coons, W. V .... March 21, 1900
906 Williamson Building, Cleveland, Ohio.

Cooper, Wm. H., (A) .... March 16, 1904
Superintendent, Chuctanunda Gas Light Company, Amsterdam, N. Y.

Copley, I. C., (A–B) .... March 16, 1904
General Manager, Fox River Light, Heat and Power Co., Aurora, Ill.

Corbus, F. G., (B–E) .... March 21, 1900
Manager, Cleveland, Dept. Welsbach Co., 167 Euclid Ave., Cleveland, Ohio.

Cowdery, E. G., (A–B–F) .... March 16, 1904
Vice-President and General Manager, The Laclede Gas Light Co., 716 Locust St., St. Louis, Mo.

Cowperthwait, B. W., (C) .... March 16, 1904
Secretary and Treasurer, Faribault Gas and Electric Co., Faribault, Minn.

Cressey, Frank A., Jr., (D) .... March 16, 1904
Manager, Modesto Gas Light, Coal and Coke Company, Modesto, Cal.

Cressler, Alfred D., (A–B–E) .... February 18, 1885
President, Kerr-Murray Manufacturing Co., Ft. Wayne, Ind.

Cressler, Alford M., (A) .... March 16, 1904
Treasurer, Kerr-Murray Mfg. Co., Ft. Wayne, Ind.

Cressler, George H., (A–E) .... March 16, 1904
Secretary, Kerr-Murray Mfg. Co., Ft. Wayne, Ind.

Critchfield, Chas. V .... March 21, 1900
Secretary and Treasurer, Hillsboro Light and Fuel Co., Hillsboro, Ohio.

Critchlow, E. C .... March 18, 1898
Manager, Citizens' Heat and Light Co., Elwood, Ind.

Cross, Philip, (A–B) .... March 16, 1904
Manager, New Business Dept., Denver Gas and Electric Co., Denver, Col.

Cullinane, J. R., (B) .... March 16, 1904
Manager Texarkana Light and Power Co., Texarkana, Texas.

Curtis, S. P., (A) .... March 16, 1904
General Superintendent, American Gas Co., 222 South Third St., Philadelphia, Pa.

Dales, J. M .... March 16, 1904
Superintendent, Electric Dept., Lincoln Gas and Electric Co., Lincoln, Neb.

Daley, Edward M .... March 16, 1904
Inspector and Assistant Superintendent, Haverhill Gas Light Co., Haverhill, Mass.

Daly, Martin B .... March 16, 1904
General Manager, East Ohio and Northwestern Ohio Natural Gas Co., 112 Bond St., Cleveland, Ohio.

Daniels, J. M., (A) .... March 16, 1904
Agent and Superintendent, Columbia Gas Light Co., 1330 Main St., Columbia, S. C.

Daugherty, George .... March 19, 1902
Foreman, Warren Gas Light Co., Warren, Ohio.

Davidson, J .... March 15, 1899
Director, Ironton Gas Co., Ironton, Ohio.

Davis, C. R .... March 16, 1904
Secretary and Treasurer, Noblesville Gas and Improvement Co., Noblesville, Ind.

Davis, Ernest H .... March 16, 1904
Treasurer, Lewiston Gas Light, Heat and Power Co. of Lewiston, West and Willon Sts. Williamsport, Pa.

Davis, S. S., (B) .... March 16, 1904
Secretary, Peoples' Power Co., Moline, Ill.

Dawes, Beman G., (A–E) .... February 3, 1897
President, Newark Gas Light and Coke Co., and Lansing (Mich.) Gas Light Co., Marietta, Ohio.

DeArmon, Chas. W. .... March 16 1892
Secretary and Treasurer, Piqua Gas Light and Coke Co., Piqua, O.

Dell, John, (A–B–E) .... February 18, 1885
President and General Manager, Missouri Fire Brick Co., 411 Olive St., St. Louis. Mo.

Dewey, V. F., (E) .... March 16, 1904
Assistant Superintendent Manufacture, Detroit City Gas Co., 37 Marston Ave., Detroit, Mich.

Dickerson, James N .... March 16, 1904
Manager and Engineer, Citizens' Gas and Fuel Co., Dunkirk, N. Y.

Dickey, Chas. H., (A–B–D) .... March 20, 1889
President, Maryland Meter Co., Baltimore, Md.

Dickey, Edmund S., (A) .... March 18, 1903
Treasurer and Manager, Maryland Meter Company, Baltimore, Md.

Dickey, Philip S., (B) .... March 15, 1893
With Maryland Meter Co., Baltimore, Md.

Dickey, R. R., (A) .... February 18, 1885
President, The Dayton Gas Light and Coke Co., S. W. Cor. Main and Second Sts., Dayton, Ohio.

Dixon, Junius S .... March 16, 1904
Superintendent Gas Manufacture, Utica Gas and Electric Co., Utica, N. Y.

Doherty, Henry L., (A–B–D–F–G–H–I) .... March 20, 1895
General Manager and Chief Engineer, American Light and Traction Co., 40 Wall St., New York, N. Y.

Dole, H. N. P .... March 16, 1904
Engineer, Columbus Gas Light and Heating Co., 135 N. Front St., Columbus, Ohio.

Dolph, Alex M .... March 18, 1903
President and Treasurer, Paris (Ky.) Gas Light Co., 3483 Evans Place, Clifton, Cincinnati, Ohio.

Doty, Paul, (A–B–E–G–H) .... March 16, 1904
Second Vice-President and General Manager, St. Paul Gas Light Co., 6th and Jackson Sts., St. Paul, Minn.

Douglas, Henry W., (A–B–E) .... March 19, 1899
General Manager, Ann Arbor Gas Co., Ann Arbor, Mich.

Droulliard, G. L .... March 18, 1893
Traveling Salesman, The Kanawha Coal and Coke Co., Fourth and Elm Sts., Cincinnati, Ohio.

Douthirt, W. F., (A–B) .... March 16, 1898
Assistant to the Treasurer, United Gas Improvement Co., Broad and Arch Sts., Philadelphia, Pa.

Dunbar, James W., (A–B) .... March 15, 1899
Superintendent, United Gas and Electric Co., 507 Bank St., New Albany, Ind.

Dwyer, Francis T., (B–E) .... March 15, 1899
Vice-President and Secretary, The Ideal Manufacturing Co., Detroit, Mich.

Eaton, Alfred B., (A–B–E) .... February 3, 1897
Western Sales Agent, The United Gas Improvement Co., 70 Wabash Ave., Chicago, Ill.

Eilbeck, A. B., (A–B)..............................March 15, 1899
General Manager, Akron Gas Co., Akron, Ohio.

Elles, Edward J., (A–B)............................March 18, 1903
Secretary and Treasurer, New Charlotte Gas Company, Charlotte, Mich.

Eustace, E. W., (A–B)..............................March 16, 1904
Superintendent Gas Department, Peoria Gas and Electric Co., Peoria, Ill.

Evans, Chas. H., (A–B).............................March 20, 1899
404 Royal Insurance Building, Chicago.

Eyman, L. E., (B)..................................March 16, 1904
President and Treasurer, Pueblo Gas and Fuel Co., Pueblo, Col.

Eysenbach, E. E., (A–B)............................March 18, 1898
General Manager Binghamton Gas Works, Binghamton, N. Y.

Faben, Chas. R., Jr., (A–B)........................March 21, 1888
General Manager, The Toledo Gas Light and Coke Co., 327 S. Erie St., Toledo, Ohio.

Faller, G. W.......................................March 16, 1904
Superintendent Distribution, Madison Gas and Electric Co., Madison, Wis.

Ferguson, B. B., (A)................................March 16, 1904
Superintendent, Portsmouth Gas Co., Portsmouth, Va.

Feurtado, R. S......................................March 18, 1903
General Superintendent, Western Gas and Improvement Co., 4401 Indiana Ave., Chicago, Ill.

Field, Frank H......................................March 19, 1902
Manager, Welsbach Co., Columbus ,Ohio.

Field, R. A...March 16, 1904
Superintendent, Rome Gas, Electric Light and Power Co., Rome, N. Y.

Forstall, Alfred E., (A–B–H)........................March 20, 1901
Consulting Gas Engineer, Secretary of the Trustees, Gas Educational Fund, 58 William St., New York, N. Y.

Forbes, James, (A–B)................................March 15, 1899
Superintendent Chattanooga Gas Light Co., 619 Cherry St., Chattanooga, Tenn.

Foster, B. P..March 16, 1898
Norwalk, Ohio.

Franklin, John......................................March 16, 1898
Superintendent Distribution, Cincinnati Gas and Electric Co., Main Ave., Norwood, Ohio.

Franklin, H. C......................................March 18, 1903
Superintendent Public Lighting, Cincinnati Gas and Electric Co., Hudson and Regent Sts., Norwood, Ohio.

Frueauff, F. W., (A–B)..............................March 16, 1904
Secretary, Denver Gas and Electric Co., Denver, Col.

Frost, William H., (A–B–C)..........................March 16, 1904
General Manager, Detroit Gas Light and Coke Co., 1998 River St., Delray, Mich.

Funkhouser, E. M.................................March 16, 1904
President, Staunton Gas Co., Staunton, Va.

Ganser, H. H., (A)...............................March 16, 1904
Superintendent, Gas Company of Montgomery County, Norristown, Pa.

Garard, J. W.....................................March 16, 1904
Vice-President and General Manager, The Ohio Fuel Supply Co., and the Federal Gas and Fuel Co., Columbus, Ohio.

Gardner, W. H., (B)..............................March 19, 1902
Treasurer and Manager, Valparaiso Fuel and Light Co., Valparaiso, Ind.

Garrison, F. L...................................March 18, 1896
President, The Kanawha Coal and Coke Co., Fourth and Elm Sts., Cincinnati, Ohio.

Gartley, W. H., (A)..............................March 21, 1888
Engineer of Works for Philadelphia, The United Gas Improvement Co., 1401 Arch St., Philadelphia, Pa.

Gassett, A. L., (B)..............................February 3, 1897
Secretary, Economy Stove and Manufacturing Co., Detroit, Mich.

George, Wm. B....................................March 15, 1899
Assistant Secretary, Union Light, Heat and Power Co., Covington, Ky.

Gillette, J. Walter, (I).........................March 16, 1904
General Manager, Consolidated Schuylkill Gas Co., 224 Bridge St., Phœnixville, Pa.

Gillette, Melville M.............................March 15, 1899
Secretary, Newark Gas Light and Coke Co., Newark, Ohio.

Gillespie, Joseph M..............................March 18, 1903
Superintendent, Washington Gas and Electric Co., Washington, C. H., Ohio.

Gould, Vernon K., (A)............................March 16, 1904
Superintendent, Bangor Gas Light Co., Bangor, Me.

Graf, Carl H., (A–C).............................March 16, 1904
General Superintendent, James T. Lynn Co., 402 Union Trust Bldg. Detroit, Mich.

Gray, A. Ross.....................................March 18, 1903
Traveling Salesman for S. R. Dresser, Bradford, Pa.

Green, James, (A–B–D)............................March 15, 1899
President of Sedalia and Fuel Co., Moberly Gas and Electric Co. and Greencastle Gas and Electric Co., Manchester and Sulphur Aves., St. Louis, Mo.

Gregory, John M..................................March 20, 1895
Superintendent, Bellefontaine City Gas Works, Bellefontaine, Ohio.

Gribbel, William S., (A).........................March 16, 1892
Manager, John J. Griffin & Co., 52 Dey St., New York, N. Y.

Guldlin, O. N., (A–B–D–E–F)......................March 21, 1888
President and Engineer, The Western Gas Construction Co., Ft. Wayne, Ind.

Gwynn, J. W., (A)................................March 21, 1888
Manager, Bucyrus Gas and Electric Light Company, Bucyrus, Ohio.

Hagerty, J. H. .... March 16, 1904
Superintendent, American Illuminating and Power Co., Americus, Georgia.

Hague, W. .... March 16, 1904
Superintendent, Forest Gas Co., Tidioute, Pa.

Hall, Andrew F. .... March 16, 1904
Superintendent and General Manager, Southbridge Gas and Electric Co., Southbridge, Mass.

Haines, Jansen, (A–B) .... March 16, 1904
Manager, Capital City Gas Light Co., Des Moines, Iowa.

Hamlink, L. C. .... March 20, 1901
With Fred Bredel Co., Milwaukee, Wis.

Hammon, W. H. .... March 16, 1904
Assistant General Manager, Union Natural Gas Corporation, Ruggery Bldg., Columbus, Ohio.

Hanley, E. W. .... March 15, 1899
Secretary and Treasurer, Dayton Gas and Fuel Co., 218 S. Jefferson St., Dayton, Ohio.

Harrop, H. B., (F) .... March 18, 1903
Chemist, Milwaukee Gas Light Co., 528 Cass Street, Milwaukee, Wisconsin.

Harper, H. D., (A–B–F) .... March 19, 1890
Manager, D. McDonald & Co., Jefferson and Monroe Sts., Chicago, Ill.

Harris, J. A., (A) .... September 17, 1884
Agent, John J. Griffin & Co., 1513 Race Street, Philadelphia, Pa.

Hauk, Chas., D., (A) .... March 20, 1895
Address Unknown.

Hayward, Sterling F., (A–B–H) .... March 18, 1891
Treasurer, Connelly Iron Sponge and Governor Co., 395 Broadway New York, N. Y.

Hedges, J. S. .... March 21, 1888
Secretary and Treasurer, Mansfield Gas Light Co., and Mansfield Electric Light and Power Co., Mansfield, Ohio.

Hedges, Wm. C. .... March 15, 1893
Mansfield, Ohio.

Helme, Wm. E., (A–B) .... March 15, 1899
Of Helme & McIlhenny, 1339 Cherry St., Philadelphia, Pa.

Hemenway, W. E. .... March 16, 1904
Superintendent, Warsaw Gas and Electric Co., Warsaw, New York.

Henderson, E. H., (A–B) .... March 20, 1895
Address Unknown.

Hendley, Joseph L., (F) .... March 16, 1904
Manager, Beloit Gas Light and Coke Co., Beloit, Wis.

Henry, Wm. G., (B) .... March 18, 1903
Vice-President, Detroit Stove Works, 2921 S. LaSalle St., Chicago, Ill.

Hess, Frank H., (E) .... March 16, 1898
Traverse City Gas Co., Traverse City, Mich.

Hesser, C. F. . . . . March 18, 1903
Superintendent, Business Promotion Department, Cincinnati Gas and Electric Co., Cincinnati, Ohio.

Hibberd, E. G. . . . . March 16, 1904
Secretary and Treasurer, Richmond Natural Gas Co., Richmond, Ind.

Hicks, Geo. C., Jr., ... March 16, 1904
Engineer, P. H. & F. M., Roots Co., Connersville, Ind.

Higgins, C. M., (A–B) . . . . March 18, 1891
With the Standard Oil Company of New York, 26 Broadway, New York, N. Y.

Highlands, E. M., (A–B) . . . . March 16, 1904
Superintendent, Clinton Gas Light and Coke Co., Clinton, Iowa.

Hilleke, A. F., (A) . . . . March 16, 1904
Superintendent United Coke and Gas Co., Glassport, Pa.

Himsworth, Hines H . . . . March 16, 1904
Assistant to Superintendent of Gas Department, Denver Gas and Electric Co., Denver, Colo.

Hodgson, John A . . . . March 16, 1904
Superintendent, The Athens Gas Co., Athens, Ga.

Hoffman, R. J . . . . March 16, 1904
President, The Hoffman Natural Gas Co., Bradford, Pa.

Holmes, A. G . . . . March 20, 1901
Secretary and Manager, Pittsburgh Meter Co., East Pittsburgh, Pa.

Howard, Chas. A., (A–B) . . . . March 16, 1904
President, Aberdeen Gas Co., Aberdeen, S. D.

Hoyte, E. S . . . . March 18, 1904
Detroit, Mich.

Hughey, W. C . . . . March 16, 1904
Superintendent Sales, Denver Gas and Electric Co., Denver, Colo.

Humphrey, A. H., (B–E) . . . . March 18, 1903
President and General Manager, General Gas Light Co., Kalamazoo Mich.

Humphreys, E. C., (E) . . . . March 20, 1901
Sales Agent, The United Cast Iron Pipe and Foundry Co., 531 Union Trust Building, Cincinnati, Ohio.

Humphreys, H. S . . . . March 16, 1904
Manager and Secretary, Humphrey Co., Kalamazoo, Mich.

Hyde, Gustavus A., (B) . . . . March 19, 1890
Engineer, Cleveland Gas Light and Coke Co., 85 Kennard St., Cleveland, Ohio.

Hyde, Henry H., (A–E–F) . . . . March 16, 1904
Secretary and Manager, Racine Gas Light Co., 305 Sixth St., Racine, Wis.

Jelliffe, C. N., (A) . . . . March 16, 1904
Auditor, American Light and Traction Co., 40 Wall St., New York, N. Y.

Jenkins, Albert F . . . . March 18, 1896
Superintendent, Newark Gas Light and Fuel Co., Newark, N. Y.

Johns, L. B. . . . . March 16, 1904
Superintendent, Dedham and Hyde Park Gas and Electric Light Co., Hyde Park, Mass.

Johnson, E. D., (A–B) . . . . March 16, 1899
President and General Manager, P. H. & F. M. Roots Co., Connersville, Ind.

Johnson, J. M . . . . March 16, 1904
Foreman Shops and Works, Durham Light and Power Co., Durham, N. C.

Johnston, John O., (B) . . . . March 21, 1900
General Manager, The Columbus Gas Light and Heating Co., Columbus, Ohio.

Jones, Howard . . . . March 21, 1894
President, The Circleville Light and Power Co., Circleville, Ohio.

Jones, Philo, (D) . . . . March 16, 1904
Superintendent at Salinas, Monterey Gas and Electric Co., Salinas, Cal.

Jones, T. C., (A–B–E) . . . . March 16, 1892
President, The Delaware Gas Co., 6 West Winter St., Delaware, O.

Kahn, Lazard, (A–B–D) . . . . March 15, 1899
Of F. & L. Kahn & Bros., Hamilton, Ohio.

Kauke, John H . . . . March 21, 1894
President and Treasurer, Wooster Gas Light Co., Wooster, Ohio.

Kehoe, Frank B . . . . March 18, 1896
Vice-President, The Portsmouth Gas Co., Portsmouth, Ohio.

Kellum, Benj. J., (A–B–F) . . . . March 18, 1903
Manager, Welsbach Co., 70 Wabash Ave., Chicago, Ill.

Kempf, John, Jr., (A–D) . . . . March 16, 1904
Superintendent Gas Service, Utah Light and Railway Co., Salt Lake City, Utah.

Kenan, Norman G . . . . February 18, 1895
President, Cincinnati Gas and Electric Co., Fourth and Plum Sts., Cincinnati, Ohio.

Kerlin, R. G . . . . March 21, 1900
705 The Nasby, Toledo, Ohio.

Keutz, J. C . . . . March 16, 1904
Storekeeper, Dayton Gas and Fuel Co., Dayton, Ohio.

Kirk, D. B . . . . March 15, 1899
Secretary and Treasurer, Mt. Vernon Gas Light Co., Mt. Vernon, O.

Kirk, F. M . . . . March 16, 1904
Kirk Woods Coal Co., 815 Williamson Bldg., Cleveland, Ohio.

Klein, B. F . . . . March 16, 1904
Gas Fixture and Brass Co., Sheriff and High Sts., Cleveland, Ohio.

Knight, John J., (A–B–E) . . . . March 18, 1903
Vice-President, Kalamazoo Gas Co., 123 South West St., Kalamazoo, Mich.

Knight, William H . . . . March 15, 1889
General Manager, Cleveland Gas Meter Co., 42 Glendale Ave., Cleveland, Ohio.

Koiner, C. W....................................March 16, 1904
Superintendent, Madison County Gas and Electric Co., Oneida, N. Y.

Landon, Hugh McK., (B)...........................March 21, 1900
Secretary and Treasurer, The Manufacturers' Gas Co., 113 Monument Place, Indianapolis Ind.

Langwith, Frank A., (C)...........................March 21, 1900
Engineer, New Haven Novelty Machine Co., 114 Fourth Ave., Newark, N. J.

Lathrop, Alanson P., (A–B)........................March 19, 1900
Vice-President and General Manager, Detroit City Gas Co., 230 Woodward Ave., Detroit, Mich.

Latta, M. Nisbet, (A)..............................March 16, 1904
Superintendent, Charlotte Electric Railroad and Power Co., Charlotte, N. C.

Law, A. R...March 16, 1904
General Manager and Superintendent, Durham Light and Power Co., Durham, N. C.

Lawlor, R. H......................................March 16, 1904
Superintendent, E. St. Louis (Ill.) Light & Gas Co.,E. St.Louis, Ill.,

Lea, Henry I., (B–E–F)............................March 18, 1903
Westinghouse Machine Co., Pittsburgh, Pa.

Leaky, Nathan G., (A–B–E).........................March 21, 1900
Assistant Secretary, Michigan Ammonia Works, Detroit, Mich.

LeBaron, L. W.....................................March 16, 1904
Superintendent Gas Plant, Albuquerque Gas, Electric Light and Power Co., Albuquerque, New Mexico.

Letang, B. E......................................March 16, 1904
Proprietor, Jackson Gas Light Co., Jackson, Cal.

Light, E. H.......................................March 20, 1901
Draftsman, Dayton Gas Light and Coke Co., Dayton, Ohio.

Light, George, (A–B)..............................March 16, 1887
Assistant Superintendent, Dayton Gas Light and Coke Co., Dayton, Ohio.

Light, Joseph, (A–B)...........................September 17, 1884
Engineer and Superintendent, Dayton Gas Light and Coke Co., 203 E. First St., Dayton, Ohio.

Lindsay, Chas. R., (A–B–E–F)......................March 18, 1903
Lindsay & Company, 170 Lake St., Chicago, Ill.

Lindsay, E. C.....................................March 16, 1904
Superintendent, Ravenna Gas and Electric Company, Ravenna, O.

Little, Francis W., (A–B)......................February 3, 1897
Vice-President, The Peoria Gas and Electric Co., 125 N. Jefferson Ave., Peoria, Ill.

Lloyd, Ernest F., (A-B-E)..........................March 16, 1902
Vice-President, The Lloyd Construction Co., President and Manager, Adrian Gas Co., 860 Greenwood Ave., Detroit, Mich.

Lord, R. S..March 16, 1904
Manager, The Hammon Coupler Co., 914 Farmers' Bank Building, Pittsburgh, Pa.

LOW, D. W..March 19, 1902
Superintendent, Alliance Gas and Electric Co., Alliance, Ohio.

LYNN, JAMES T., (A-B-E)..............................March 21, 1900
President, Port Huron, Gas Co., 402 Union Trust Building, Detroit Mich.

LYNN, JOHN R..March 15, 1899
Superintendent, Waterloo Gas and Electric Co., 310 Fourth St., Waterloo, Iowa.

McADAM, BRICE, (B-F)................................March 15, 1899
Superintendent Distribution, Milwaukee Gas Light Co., 847 Humbolt Ave., Milwaukee, Wis.

McCALLUM, J. N......................................March 16, 1904
Auditor, Michigan City and Northern Indiana Gas Co., Michigan City, Ind.

McCORMACK, E. T.....................................March 16, 1892
Wilmington, Ohio.

McDONALD, ALBERT, (A)...............................March 16, 1904
Superintendent, Metric Metal Works, Erie, Pa.

McDONALD, DONALD, (A-B).............................March 15, 1893
President, Kentucky Heating Co., Louisville, Ky.

McDONALD, DONALD, (A-B).............................March 21, 1894
Manager, D. McDonald & Co., Albany, N. Y.

McDONALD, WM., (A-B-D)..........................September 17, 1884
Secretary and Treasurer, Bath Gas Co., 51 Lancaster St., Albany, N. Y.

McGRAW, F. J..March 16, 1904
Manager, Downing Gas Co., Downington, Pa.

McILHENNY, FRANCIS S................................March 16, 1.04
President, Peoples' Gas Company of Pottstown, 1001 Chestnut St., Philadelphia, Pa.

McILHENNY, JOHN, (A-B)..............................March 20, 1899
Of Helme and McIlhenny, 1339 Cherry St., Philadelphia, Pa.

McILHENNY, JOHN D., (A-B-E).........................March 16, 1892
President, Gas Company of Montgomery Co., Morristown, Pa., 1339 Cherry St., Philadelphia, Pa.

McLEAN, GEORGE, (A-B)...............................March 16, 1904
President and Manager, Key City Gas Co., Dubuque, Iowa.

McMAHON, J. W.......................................March 16, 1904
Superintendent, The North-Western Ohio Natural Gas Co., 520 Jefferson Ave., Toledo, Ohio.

McMILLAN, GEORGE, (B)...............................March 16, 1904
Vice-President, Treasurer and General Manager, LaCrosse Gas and Electric Co., 222 Main St., LaCrosse, Wis.

McMILLAN, JOHN......................................March 20, 1901
With Welsbach Co., 167 Euclid Ave., Cleveland, Ohio.

MADDEN, JAMES.......................................March 16, 1904
Foreman, Greenville Gas Co., Greeenville, Pa.

MAGEE, ROBERT S.....................................March 16, 1904
Traveling Salesman, Kanawha Fuel Co., Cincinnati, Ohio.

MALONE, M. E., (B–F) .... March 19, 1902
Superintendent Gas Department, Denver Gas and Electric Co., Denver, Col.

MALONEY, ANDREW P .... March 15, 1899
Land Title Bldg., Philadelphia, Pa.

MANN, HOWARD E., (A) .... March 16, 1904
Superintendent Works No. 2, Cleveland Gas Light and Coke Co., Cleveland, Ohio.

MANCOURT, EDWARD M .... March 20, 1901
Western Manager, Fairmount Coal Co., Majestic Bldg., Detroit, Mich.

MANSUR, JOHN H., (A–B) .... March 20, 1895
President, Keytsone Meter Co.; also President, Consolidated Schuylkill Gas Co. of Phœnixville, Pa., Royersford, Pa.

MANY, F. B .... March 15, 1899
District Manager, Welsbach Street Lighting Company of America, 809 Cuyahoga Bldg., Cleveland, Ohio.

MARKS, R. J .... March 16, 1904
Manager, Lexington Gas Co., Lexington, Ky.

MARKS, WM. D., (A) .... March 20, 1901
President, Consolidated Railway and Lighting Co.; Director, City Heat and Light Co.; Vice-President, Durham (N. C.) Light and Power Co., 216 Bourse, Philadelphia, Pa.

MARTIN, FREEMAN DRAKE .... March 16, 1904
Superintendent and Treasurer, Fort Scott Gas and Electric Co., Fort Scott, Kansas.

MASON, C. T., (E) .... March 21, 1900
Traveling Salesman, George M. Clark & Co., 72 Lake St., Chicago, Illinois.

MASON, JOHN T .... March 21, 1900
Superintendent, 3d Ward Gas Works, Milwaukee, Wis.

MAXON, J. H., (B) .... March 18, 1896
Athens, Ga.

MAYER, JOHN L .... March 16, 1904
Superintendent, Hazleton Gas Light Co., Hazleton, Pa.

MAYER, JOSEPH .... March 16, 1904
Superintendent, Lakewood Gas Company, Lakewood, N. J.

MAYERS, J. A., (A–B) .... March 16, 1893
Gas Engineer, Edison Bldg., 44 Broad St., New York, N. Y.

MEGIE, BENJ. F .... March 18, 1903
Manager Cincinnati Dept., Welsbach Co., Cincinnati, Ohio.

MILLER, ALTEN S., (A–B–E) .... March 15, 1893
Manager, Consolidated Gas Co. 5 West Baltimore St., Baltimore, Md.

MILLER, C. O. G., (A–D) .... March 16, 1904
President, Pacific Lighting Co., 508 Montgomery St., San Francisco, Cal.

MILLER, R. W .... March 16, 1904
Superintendent, Conneaut Gas Light and Fuel Co., Conneaut, O.

Miller, W. A., (A–B)........................March 19, 1902
Superintendent of Manufacture, Cincinnati Gas and Electric Co., Cincinnati, Ohio.

Miller, W. H........................March 16, 1904
Superintendent, Bangor Gas Co., Bangor, Pa.

Milne, D. S........................March 21, 1888
Secretary and Treasurer, Marietta Gas Co., Marietta, Ohio.

Milsted, Wm. M., (A–B–D–E)........................March 15, 1899
Secretary, The American Meter Co., Eleventh Ave., and Forty-Seventh St., New York, N. Y.

Montgomery, Randall........................March 15, 1899
Manager, Youngstown Consolidated Gas and Electric Co., Youngstown, Ohio.

Moon, O. P........................March 16, 1898
General Manager, National Vapor Stove and Mfg. Co., Lorain, O.

Moore, Edwin A........................March 16, 1904
President, American Coke and Gas Construction Co., Camden, N. J.

Morreau, Albert........................March 21, 1900
President, The Morreau Gas Fixture Mfg. Co., Cleveland, Ohio.

Morris, Daniel........................March 16, 1904
Secretary and Superintendent, Greenville Gas Light Co., Greenville, Ohio.

Morris, W. Cullen, (A)........................March 16, 1904
Engineer, New Amsterdam Gas Co., Ravenswood, Long Island City, N. Y.

Moses, Frank D., (A–B)........................March 16, 1898
Gas Engineer and Contractor, 147 E. State St., Trenton, N. J.

Motley, Geo. L........................March 16, 1904
President and General Manager, Lowell Gas Light Co., 22 Shattuck St., Lowell, Mass.

Mulholland, S. E........................March 19, 1902
Secretary and Treasurer, Lima Gas Co., Lima, Ohio.

Mullen, John J........................March 18, 1903
Traveling Salesman, The Schneider & Trenkamp Co. of Cleveland, 726 York St., Newport, Ky.

Neeley, J. D. S., (B)........................March 20, 1901
General Superintendent, Lima Gas Co., Lima, Ohio.

Nettleton, Chas. H., (A–B–C)........................March 16, 1904
President, New Haven Gas Light Co. and Derby Gas Co., Derby, Conn.

Olds, H. L., (B)........................March 21, 1900
Superintendent, The City of Lincoln Gas Co., Lincoln, Ill.

Osborn, H. H........................March 19, 1902
Salesman, American Tank and Fixture Co., Chicago, Ill.

Osbourne, E. M........................March 16, 1904
Superintendent, Light and Fuel Co., Valparaiso, Ind.

Osius, George, (A–B)........................March 18, 1890
Secretary and Treasurer, Michigan Ammonia Works, Detroit, Mich.

Owens, H. G. .... March 16, 1704
Superintendent, The Coshocton Gas Co., Coshocton, Ohio.

Palmer, Louis T., (A–B) .... March 18, 1903
President and General Manager, Niagara Light, Heat and Power Co., Tonawanda, N. Y.

Parker, Geo. W., (A–B) .... March 20, 1901
Eastern Agent, Parker-Russell Mining and Manufacturing Co. of St. Louis, 45 Broadway, New York, N. Y.

Pattrell, C. B .... March 20, 1901
Superintendent, Mansfield Gas Light Co. and Mansfield Electric Light and Power Co., Mansfield, Ohio.

Payne, A. I .... March 16, 1904
Manager and Secretary, Nelson Coke and Gas Co., Nelson, B. C.

Payne, Frank H., (A–B) .... March 16, 1904
Manager, Metric Metal Works, Erie, Pa.

Pearson, John R., (B) .... March 16, 1904
Assistant to the President, Indianapolis Gas Company, Indianapolis, Ind.

Pelton, B. F .... March 16, 1904
St. Paul Gas Light Co., St. Paul, Minn.

Pennoyer, C. H., (D) .... March 16, 1904
Secretary and Manager, United Gas and Electric Co., 18 S. Market St., San Jose, Cal.

Perkins, B. W., (B–E) .... March 21, 1900
Superintendent, The South Bend Fuel and Gas Co., 301 E. Jefferson St., South Bend, Ind.

Perry, A. T .... March 16, 1896
Manager, Barrett Mfg. Co., 1213 Williamson Bldg., Cleveland, O.

Persons, Fred R., (A–B–E) .... March 20, 1889
Representative, The Maryland Meter Co. of Baltimore, 327 S. Erie. Toledo. Ohio.

Pew, John Glenn .... March 16, 1904
Assistant Manager, Peoples' Natural Gas Co., 248 Fourth Ave., Pittsburgh, Pa.

Philipp, E. B .... March 16, 1886
Gas Engineer, 78 Ruggery Bldg., Columbus. Ohio.

Pinkney, E. A., (A) .... March 16, 1904
Superintendent, Sag Harbor Lighting Co., Sag Harbor, N. Y.

Plummer, H. W .... March 16, 1904
Secretary, Asheville, Electric Co. Asheville, N. C.

Porter, Joseph F., (A–B) .... March 16, 1904
President and Treasurer, Alton Gas and Electric Co., Alton, Ill.

Powell, J. H .... March 15, 1893
Upper Sandusky, Ohio.

Powell, Wm. R .... March 18, 1903
Secretary and Treasurer, The Columbus Gas Company, Columbus, Ohio.

Power, John J .... March 16, 1904
Superintendent, Cumberland Gas Light Co., Cumberland, Md.

POWERS, EDGAR T., (A)..............................March 16, 1904
Secretary, Consolidated Gas Co., Baltimore, Md.

PRATT, EDWARD G., (A–B–F)........................March 16, 1904
Vice-President and General Manager, Milwaukee Gas Light Co., Milwaukee, Wis.

PRICE, CHAS. R......................................March 16, 1904
Treasurer, New Bedford Gas and Edison Light Co., New Bedford, Mass.

PRICE, W. W...March 21, 1901
General Manager, Dayton Pipe and Cable Coupling Co., 125 Mill St., Dayton, Ohio.

PRINTZ, CHAS. H., (E)..............................March 15, 1899
Representative, Missouri Fire Brick Co., 411 Olive St.,St. Louis, Mo.

PRINTZ, EUGENE, (A–B)..........................September 17, 1884
Superintendent, Zanesville Gas Light and Coke Co., N. Sixth St., Zanesville, Ohio.

PURCELL, THEO. V., (A–B)..........................March 16, 1904
General Manager, Ogden Gas Co., 115 Dearborn St., Chicago, Ill

QUACKENBUSH, CHAS. H., (A)........................March 16, 1904
Superintendent Gas Dept., Merion and Radnor Gas and Electric Co., Ardmore, Pa.

REITMEYER, A. F., (A–B)...........................March 16, 1904
Superintendent, Secretary and Treasurer, Perth Amboy Gas Light Co., 148 Smith St., Perth Amboy, N. Y.

RETTEW, C. H.......................................March 16, 1904
Superintendent, Greenville Gas, Electric Light and Power Co., Greenville, S. C.

RICHARDS, F. M., (F)...............................March 16, 1904
Superintendent Stations, Madison Gas and Electric Co., Madison, Wis.

RICHARDSON, W. W..................................March 16, 1904
58 Coal and Iron Exchange Bldg., Buffalo, N. Y.

RITSCHY, LEWIS J., (I).............................March 16, 1904
Assistant Superintendent, Laclede Gas Light Co., 148 Rutger St., St. Louis, Mo.

RITTER, CHAS. S....................................March 21, 1900
Chief Clerk, Detroit City Gas Co., 230 Woodward Ave., Detroit, Mich.

ROBB, J. M..March 16, 1904
Chief Clerk, Peoria, Gas and Electric Co. Peoria, Ill.

ROOHAN, PATRICK F., (A)..........................March 16, 1904
Superintendent, Saratoga Gas, Electric Light and Power Co., Saratoga Springs, N. Y.

ROPER, GEORGE D., (A–B–D–E)......................March 16, 1892
President, Eclipse Gas Stove Co., Rockford, Ill.

ROSS, J. CHAS., (A)................................March 16, 1904
General Manager, Steubenville Traction and Light Co., Steubenville, Ohio.

ROSS, W. H..March 16, 1904
Superintendent, Bowling Green Gas Co., Bowling Green, Ohio.

Roycroft, Thos. .... March 16, 1904
Superintendent, Grand Forks Gas and Electric Co., Grand Forks, N. D.

Russell, D. R., (A–B–D–E) .... March 19, 1890
Vice-President, The Parker-Russell Mining and Manufacturing Co., 417 Pine St., St. Louis, Mo.

Sapp, Dwight E. .... March 21, 1900
President, The Coshocton (Ohio) Gas Company, Mount Vernon, O.

Savage, George .... March 21, 1900
Engineer Works, Suburban Gas Co. of Philadelphia, Chester, Pa.

Schall, H. D., (F) .... March 18, 1903
Salesman, Detroit Stove Works, 737 Park Ave., Beloit, Wis.

Schmidt, Emil G. .... March 16, 1904
General Manager, Springfield Gas Light Co., Springfield, Ill.

Schnierle, E. H. .... March 16, 1904
Superintendent, Salem Gas Co., Salem, Ohio.

Schniewind, Dr. F., (A–J) .... March 19, 1902
General Manager, The United Coke and Gas Company, 17 Battery Place, New York, N. Y.

Schwarm, C. A., (A) .... March 20, 1901
Superintendent, Hornell Gas Light Co., P. O. Box 326, Hornellsville, N. Y.

Scott, G. C. .... March 16, 1904
Secretary and Superintendent, Central Ohio Natural Gas and Fuel Co., 39 N. Front St., Columbus, Ohio.

Seamon, J. F. .... March 16, 1892
General Manager and Secretary, The United Light Co., Uniontown, Pa.

Sears, C. W. .... March 18, 1903
32 S. Washington Ave., Columbus, Ohio.

Shacklette, R., (E) .... March 18, 1903
Cashier, Adrian Gas Co., Adrian, Mich.

Shattuck, John D., (A–B) .... March 19, 1902
Vice-President and Manager, Philadelphia Suburban Gas Co., 517 Market St., Chester, Pa.

Shaw, Herbert S., (C) .... March 16, 1904
Treasurer and Superintendent, Webster Electric Co., Webster, Mass.

Sherwood, E. J., (F) .... March 16, 1904
Superintendent Gas Department, Lincoln Gas and Electric Co., Lincoln, Neb.

Shelton, F. H., (A–B–C) .... March 18, 1891
Secretary and Treasurer, Various Gas Companies, 1004 Pennsylvania Bldg., Fifteenth and Chestnut Sts., Philadelphia, Pa.

Simpson, J. .... March 20, 1901
General Sales Representative, The Portable Electric Power and Light Co., 188 Railroad Ave., Jersey City, N. J.

Sites, Wm. M. .... March 16, 1904
Superintendent Gas Dept., Oklahoma Gas and Electric Co., Oklahoma City, O. T.

Slater, A. B., Jr., (A-B-C) .... March 16, 1904
Engineer, Western Gas Construction Co., Fort Wayne, Ind.

Sloper, H. T., (A) .... March 16, 1904
Secretary, New Britain Gas Light Co., New Britain, Conn.

Smart, George M .... March 16, 1897
Secretary, Dayton Gas Light and Coke Co., S. W. Cor. Main and Second Sts., Dayton, Ohio.

Smith, Arthur C .... March 16, 1904
Secretary and Treasurer, Valparaiso Light and Fuel Co., Valparaiso, Ind.

Smith, Arthur M .... March 16, 1904
Treasurer, The Gas Machinery Co., 720-722 Citizens' Building, Cleveland, Ohio.

Smith, Ernest B .... March 16, 1904
Secretary, The Coshocton Gas Co., Coshocton, Ohio.

Speer, R. I., (B-E) .... March 16, 1904
Manager, Pulaski Gas Light Co., Little Rock, Ark.

Stacey, A. J., (B-E) .... March 21, 1900
Sales Agent, Stacey Manufacturing Co., 239 Mill St., Cincinnati, O.

Stacey, F. A .... September 17, 1884
President, Chillicothe Gas Light and Water Co., Chillicothe, Ohio.

Stacey, James E., (A-B) .... March 21, 1894
President, Stacey Manufacturing Co., 239 Mill Street, Cincinnati, O.

Starr, Howard W .... March 16, 1904
Engineer, Mohawk Gas Co., Schenectady, N. Y.

Steele, George P .... March 16, 1898
President, Painesville Gas Light and Coal Company, Painesville, O.

Steenbergen, Chas. L .... March 20, 1901
Superintendent, Gallipolis Gas and Coke Company, Gallipolis, O.

Steinwedell, W. E., (A-B-E) .... March 18, 1903
Secretary, The Gas Machinery Co., 721 Citizens' Bldg., Cleveland, Ohio.

Stevens, J. G., (B) .... March 19, 1890
Sales Agent, Welsbach Co., 444 Seventh Ave., Pittsburgh, Pa.

Steward, Robert Bruce, (A-B) .... March 20, 1901
Vice-President, D. M. Steward Manufacturing Co., Chattanooga, Tenn.

Stiles, Aaron K., (B) .... March 16, 1904
President, Streator Gas Light Co., Streator, Ill.

Stockstrom, Lewis .... March 19, 1890
Secretary and Manager, Quick Meal Stove Company, St. Louis, Mo.

Stone, F. W .... March 16, 1898
Manager, Ashtabula Gas Co., Ashtabula, Ohio.

Strain, G. A., (B) .... March 19, 1902
Superintendent Three Rivers Gas Co., Three Rivers, Mich.

Stratton, S. S., (A-B-E-F) .... March 20, 1899
Agent, The Maryland Meter Co., 88-92 West Jackson Blvd., Chicago, Ill.

Sullivan, R. B..March 16, 1904
Assistant Treasurer, Denver Gas and Electric Co., 405 Seventeenth St., Denver, Col.

Summers, T. W..March 16, 1904
Manager, Ithaca Gas Light Co., Cor. Cayuga and Green Sts Ithaca, N. Y.

Tayler, George H., (A–B).......................September 17, 1884
Secretary, Treasurer and Superintendent, Warren Gas Light Co., 209 Main St., Warren, Ohio.

Templeton, E. S., (B)..............................March 18, 1896
Secretary and Treasurer, Ashtabula (Ohio) Gas Co., President, Greenville Gas Co., Greenville, Pa.

Terhune, Chas. F., (A–B)..........................March 21, 1900
Vice-President, Wm. M. Crane Co., 1133 Broadway, New York, N. Y.

Thomas, Chas. G. M., (A)..........................March 16, 1904
Vice-President and General Manager, Newton and Flushing Gas Co., 97 Main St., Flushing, N. Y.

Thompson, Herbert W..............................March 16, 1904
Purchasing Agent, Denver Gas and Electric Company, Denver, Col,

Thompson, F. deV., (A–C)..........................March 16, 1904
General Manager, Springfield Gas Light Co., Springfield, Mass.

Thompson, John A..................................March 20, 1901
Treasurer, The Lebanon Gas Co., Lebanon, Ohio.

Tippy, B. O., (A–B–E)..............................March 16, 1904
Superintendent of Manufacture, Detroit City Gas Co., Detroit, Mich.

Tittle, Scott M.....................................March 18, 1903
Manager, The Lebanon Gas Co., Lebanon, Ohio.

Tracey, Walter B..................................March 16, 1904
Traveling Salesman. Spang Chalfant & Co., Pittsburgh, Pa.

Travis, Frank M., (A–B–C)........................March 16, 1904
58 Church St., Torrington, Conn.

Trenkamp, H. J., (A)...............................March 15, 1899
Secretary, Schneider & Trenkamp Division American Stove Co., 479–511 Case Ave., Cleveland, Ohio.

Turney, Harry D....................................March 21, 1900
Director and Member Executive Committee, Columbus (Ohio) Gas Light and Heating Co., 80 Broadway, New York, N. Y.

Tuttle, W. B., (A)..................................March 16, 1904
General Manager, Consolidated Gas Company of New Jeresy, 168 Broadway, Long Branch, N. J.

Uteck, Clarence...................................March 16, 1904
Foreman of Works, Streator Gas Light Co., Streator, Ill.

Vance, J. C..March 16, 1904
Superintendent, Hazlewood Gas Co., 1109 Madison Ave., Anderson, Ind.

Van Wie, Edwin G., (A–B–E)......................March 16, 1892
Manager Gas Appliance Dept., Detroit Stove Works, Detroit, Mich.

WALKER, WILLIAM L., (A–C)........................March 16, 1904
Superintendent Gas Dept., Fitchburg Gas and Electric Light Co., 374 Main St., Fitchburg, Mass.

WARMINGTON, DANIEL R., (A–B)......................March 16, 1892
Vice-President and General Manager, Peoples' Gas Light Co., 410 Pearl St., Cleveland, Ohio.

WARREN, EDRIC C..................................March 20, 1899
Secretary and General Manager, Century Stove and Manufacturing Co., Johnstown, Pa.

WATT, ROBERT.....................................March 21, 1894
Denver Gas and Electric Co., Denver, Col.

WATTS, CHAS. L...................................March 16, 1904
Local Manager, Logan Natural Gas and Fuel Company, Ashland, O.

WEBER, E. S......................................March 16, 1904
Superintendent, Gas, Heat and Power Co., Mechanicsburg, Pa.

WELLS, L. W., (A)..............................February 3, 1897
Superintendent, Canton Gas Light and Coke Co., 137 E. Fifth St., Canton, Ohio.

WENDLER, B. F....................................March 20, 1901
The Miami Valley Gas and Fuel Co., Dayton, Ohio.

WEST, GEORGE M...................................March 16, 1904
Superintendent, Standard Gas Co., Danville, Pa.

WEST, WILLIAM D., (B–E)..........................March 20, 1901
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WHIPPLE, HENRY S., (A–B).........................March 16, 1904
Superintendent, Rockford Gas Light and Coke Co., 201 Mulberry St., Rockford, Ill.

WHYSALL, GEORGE, (B).............................March 19, 1890
General Manager, Columbus, Delaware and Marion Electric Railroad Co., Delaware, Ohio.

WICKHAM, LEIGH, (A–B–E–F)........................March 16, 1892
Representative, Parker-Russell Mining and Manufacturing Co., 417 Pine St., St. Louis, Mo.

WILKIN, JOHN T., (A–H)...........................March 16, 1904
Engineer, Connersville Blower Co., Connersville, Ind.

WILLIAMS, C. H., (F–H)...........................March 16, 1904
General Superintendent, Madison Gas and Electric Co., Madison, Wis.

WILSON, EDWARDS F...............................March 16, 1904
Chemist, Westmoreland Coal Co., Irwin, Pa.

WITHERDEN, GEORGE M., (B)........................March 15, 1899
Representative, with Jno. J. Griffin & Co., 1513 Race St,. Philadelphia, Pa.

WOLFF, S. E., (A–E)..............................March 16, 1904
Secretary and General Manager, Jackson Gas Co., 260 Main St., Jackson, Mich.

WONES, W. R.....................................March 15, 1893
Superintendent, Union Heat, Light and Power Co., Covington, Ky.

WOODWARD, RALPH, (A–B–C).........................March 16, 1904
General Manager, Pittsfield Coal Gas Co., Pittsfield, Mass.

Woolcott, H. . . . . March 16, 1904
Secretary, Consolidated Railways, Light and Power Co., Wilmington, N. C.

Woolen, A. L., (A) . . . . February 3, 1897
501 West 146th St., New York, N. Y.

Wordell, H. H. . . . . March 18, 1903
Representative, Welsbach Company, 423 Main Street, Cincinnati, Ohio.

Wyness, Alex., Jr. . . . . March 16, 1904
Superintendent and Secretary, Geneseo Gas Light Co., Geneseo, N. Y.

Yawger, Edwin, (H) . . . . March 21, 1900
Westinghouse, Church, Kerr and Co., Westinghouse Building, Pittsburgh, Pa.

Yocum, Winfield H. . . . . March 16, 1904
Light and Railroad Co., Peekskill, N. Y.

York, George W. . . . . March 20, 1901
Secretary and Treasurer, The Alliance (Ohio) Gas and Electric Co., 309 Garfield Bldg., Cleveland, Ohio.

Young, Peter, (A–B–E) . . . . March 21, 1900
Secretary and Treasurer, The Conneaut (Ohio) Gas Light and Fuel Co., 202 Lewis Bldg., Pittsburgh, Pa.

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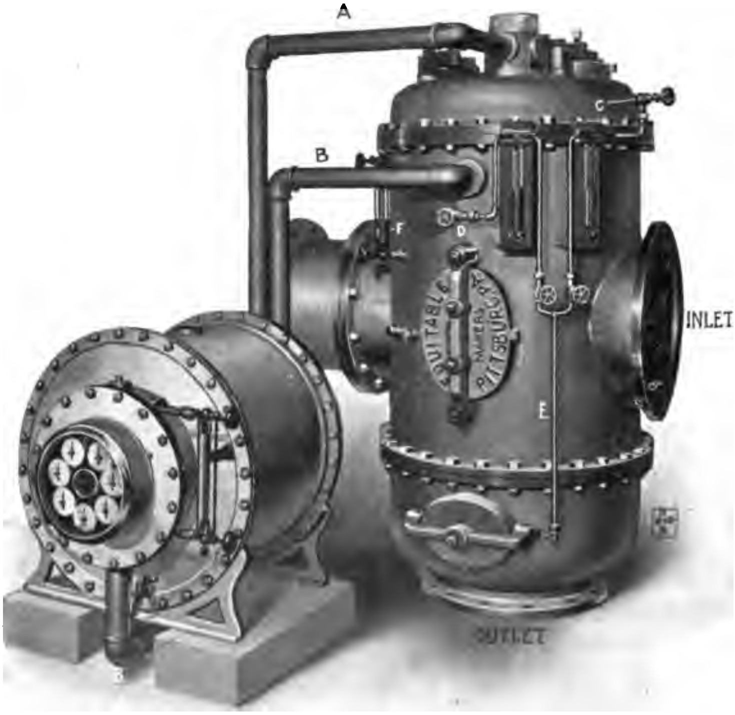

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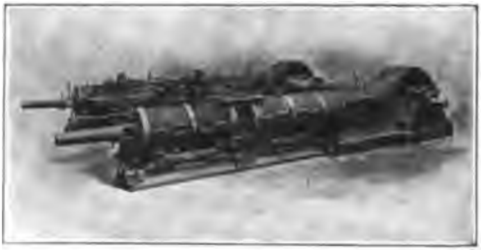

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